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Contents

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JOURNAL
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AMERICAN WATER WORKS ASSOCIATION

Vol. 34 August 1942 No. 8

Honolulu Wartime Water Works Activity

By Frederick Ohrt

THE Board of Water Supply serves only the city of Honolulu, T.H., (population 200,000). Rural areas (population 110,000) on the Island of Oahu are served by the Suburban Water Division of the municipal department of public works. The city water works has 26,000 services, pumps from 20 to 30 mgd. and has revenues of $1,500,000 per year. Privately operated wells within the city pump about 14 mgd. from the artesian areas.

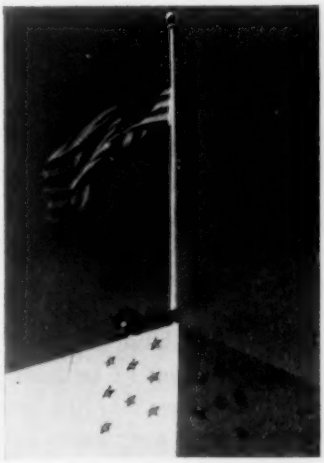


FIG. 1

The Board of Water Supply is a semi-autonomous, non-political agency, which, on a self-sustaining basis, operates a $13,000,000 water works, ownership of which rests in the city and county government.

Fully 90 per cent of the city's water supply is taken from five artesian areas underlying Honolulu. The remainder comes from mountain sources at elevations up to 900 ft. The artesian areas are natural "bombproofs." The problem of the board is to protect surface installations, which include three main steam pumping stations, nine electrically operated booster stations, 25 equalizing reservoirs, two aerators and 325 miles of pipe lines.

A contribution by Frederick Ohrt, Mgr. & Chief Engr., Board of Water Supply, City and County of Honolulu, T.H.

There are also two electrically operated underground stations on the basal water table about 25 ft. above sea-level at the bottom of 300-ft. inclined shafts, and a third is being built.

Distribution System Protection

Precautions for the protection of the water distribution system in Honolulu were begun seventeen years ago, when the legislature placed the city's water works on a non-political self-sustaining basis. Since numerous military objectives are located in and around Honolulu, the first step for water service protection was decentralization of pumping operations. This was accomplished by the installation of three main steam pumping units, all of which are inter-connected through headers, but each of which is capable of independent operation. Initial outlay for the steam units was about seven times greater than it would have been for electrical units obtaining power from a central generating source, but the cost of water delivered worked out at about the same amount over a 30-year amortization period.

The war factor and a remote danger from earthquake damage were taken into consideration in the design of the pumping stations, reinforced concrete walls affording protection from blast, fragmentation and possible temblors. Hawaii is in the Pacific volcanic earthquake belt but thus far has escaped a major quake.

In its developments and operations during the ensuing seventeen years the board has never entirely lost sight of the possibility of defense against enemy attack. Buildings and grounds were designed to harmonize with their surroundings in the dual interest of civic sightliness and ready adaptability to camouflage.

Pipe lines have been valved insofar as has been possible, with a view to continuous service in areas adjacent to those in which breaks occur. This plan, of course, has not been 100 per cent effective for the Board of Water Supply took over many miles of old mains when it assumed control, and it has not been possible to place four valves at each street intersection, which is necessary for ideal protection. Omission of this precaution is false economy. New construction has kept this principle in view and corrections have been made in the older parts of the system as rapidly as conditions have permitted.

Fortunately, Honolulu's water can be served in its natural state, so chlorination has not been a major problem, being required only when main breaks occur. Portable chlorinators are provided for the use of gas and liquid chlorine and hypochlorite solution when required, and, as a war precaution, the board is prepared to introduce chlorine under pressure directly into the mains in the event of multiple breaks.

War Preparations

Active preparedness for war by the Board of Water Supply began early in 1940. General Charles D. Herron, commanding the Hawaiian Department, and his successor, General Walter C. Short, like the present commanding general, Delos C. Emmons, and their aides, recognized the importance of water supply in national defense and the naval authorities were equally co-operative. Colonel Melvin L. Craig, Provost Marshal for the Hawaii Department, contacted the water works in June 1940 for a general discussion of protective measures and agreed that the 500-mil.gal. open reservoirs above the city might be a source of danger. These reservoirs, once a source of the city's water supply, are maintained as flood control units and as possible sources of artesian infiltration, but are not drawn on directly for the present water supply. Colonel Craig approved the board's proposal that the level in these reservoirs be dropped to about 20 per cent of capacity, at which they are now maintained, to eliminate any danger from flood in the event that they should become enemy targets.

Through the co-operation of Colonel Craig, also, the Board of Water Supply was able to obtain Army guards for its principal installations, which saved a considerable sum of money that was put into the purchase of emergency materials, supplies and equipment which had to be brought into the Islands. The 2,000 miles of water transportation between Hawaii and the Mainland is a factor that must be reckoned with in all defense activities in the Territory.

An interesting highlight of the defense preparations was the appearance of the photograph of an Army sentry on the Board of Water Supply Building (Fig. 1), with the caption "On the Alert," in the *Honolulu Star Bulletin* on the evening of December 6, 1941. The Japs struck Pearl Harbor and Honolulu the next morning.

These guards, posted before the Pearl Harbor attack to protect the water works from saboteurs, have been maintained at principal installations since the war began. They are supplemented by special police guards, supplied by the Honolulu Police Department, and, during "alerts," by members of the Business Men's Training Corps, a volunteer organization operating under the direction of the Provost Marshal. However, provision has been made for the Board of Water Supply to take over the guarding of its own installations if and when an invasion attack is made. To this end, pumping station personnel has been armed with riot guns, pistols and helmets by the Provost Marshal and has been drilled in marksmanship and guard duty. Pump personnel not on duty turns out on call to take over protection of the stations, releasing the soldiers ordinarily stationed there for front line service with their own organizations.

Another early activity in the preparedness period was the installation of radios (purchased in December 1940) in all principal field units, many of which have purpose-built bodies for construction and maintenance work. These radios (one- and two-way) operate through the police radio system

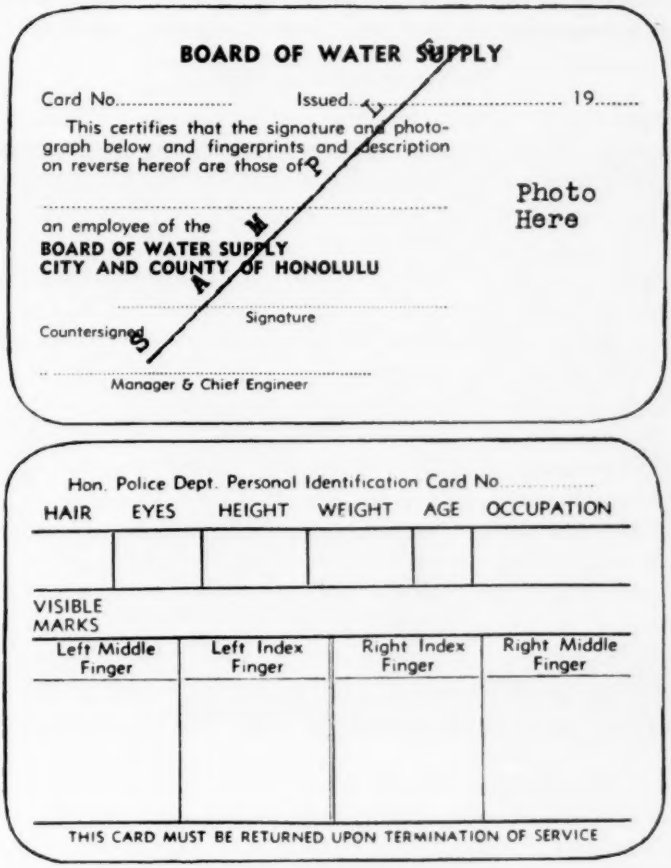
Emergency Stores and Appropriations

In 1939, a comprehensive valve map system was undertaken. In 1940 and 1941 the Board of Water Supply worked in close co-operation with the Mayor's Major Disaster Council, which formulated the city's civilian defense program. As chairman of the council's committee on water and water supply, the Manager and Chief Engineer of the Board of Water Supply made a strong recommendation to the Territorial authorities that at least $150,000 of a preparedness fund appropriated by the legislature be employed in the purchase of materials, supplies and equipment to be stored in the Territory against emergencies. It was pointed out that the Board of Water Supply had made similar purchases beyond its normal requirements to the limit of its financial ability (more than $200,000 between May and November 1941), but that if unused for war emergencies, it would ultimately absorb most of the Territory's emergency stock and pay for it in the course of future normal operations. No action was obtained on this recommendation, however, and when war came the supply situation was grave. The problem was then placed before Colonel A. K. B. Lyman, department engineer, who recognized its gravity and arranged to have supplies, equipment and materials valued at $300,000 brought into Hawaii and held in reserve for water works contingencies.

The Board of Water Supply's first defense appropriation was $15,000, voted on May 8, 1941, for the purchase of chain link fence with barbed wire top with which the principal installations have been enclosed. In that same month two further appropriations, one of $32,000 and another of $100,000, were made for emergency purchases additional to supplies laid in for normal operations, largely in excess of usual requirements. Another emergency appropriation of $56,000 was made in October 1941 and an additional $6,000 in November. The water works felt that war was inevitable and did its utmost to be prepared.

Anticipating the confusion over employee identification that arises during emergencies, Board of Water Supply employees voluntarily agreed to be photographed, fingerprinted and registered at the police department in December 1940 and received identification cards (Fig. 2) that alone have survived among the many that sprang into existence with the outbreak of war. Board of Water Supply passes are still officially recognized by civil and military authorities.

Blackout and dispersion of vehicular equipment were the first problems faced on December 7, with splinter, blast and bomb protection coming immediately after. Floodlights that had been installed at the principal water works units during the preparedness period were supplanted by blackout ventilators, subdued lighting and similar blackout precautionary


BOARD OF WATER SUPPLY

Card No..... Issued..... 19.....

This certifies that the signature and photograph below and fingerprints and description on reverse hereof are those of

.....

Photo Here

an employee of the
BOARD OF WATER SUPPLY
CITY AND COUNTY OF HONOLULU

.....
Signature

Countersigned

.....
Manager & Chief Engineer

Hon. Police Dept. Personal Identification Card No.....

HAIR	EYES	HEIGHT	WEIGHT	AGE	OCCUPATION

VISIBLE MARKS

Left Middle Finger	Left Index Finger	Right Index Finger	Right Middle Finger

THIS CARD MUST BE RETURNED UPON TERMINATION OF SERVICE

FIG. 2. Face and Reverse of Board of Water Supply Identification Card

measures. In the pumping stations all lights were lowered below the window levels, which are high in the walls, and shaded by large hoods. All lights in pumping stations were reduced to six watts and those from which there might be reflection against polished machinery were supplied with natural ruby globes. Pin-point white lights were placed behind oil sight glasses and ruby lights were installed at water and steam gages.

Blast walls were placed wherever needed, inside and outside the plant. Some are 12-inch reinforced concrete, others 13½-inch cinder brick, the material being determined by the location and purpose of the wall.

Skylights have been protected with reinforced concrete slabs so placed as not to interfere with ventilation and window panes given protective covering of white canvas pasted on the glass and varnished as a safeguard against glass fragmentation in rooms where daylight is required.

Rearrangement of Shifts

Rearrangement of shifts for pumping station personnel was necessitated by the blackout curfew which forbids travel on the streets at night. The morning shifts work as usual from 8 A.M. to 4 P.M., with one day off each week. The two later shifts have been consolidated. A pumpman comes on shift at 4 P.M. and works through to 8 A.M., then is off for 36 hours, which time is increased once each week to 56 hours to allow for his day off. This arrangement has worked out satisfactorily to both men and administration.

Raid procedure in the pumping stations is governed by the quantity of water in the equalizing reservoirs and by the demand for water at the time. Whenever possible the pumps are shut down during raids, on the theory that less damage would be done by a bomb hit on machinery that is not moving. Fortunately, storage distribution permits this; but the pumps are in readiness to come back on the line at a moment's notice.

Control of water works operations is centralized in an underground station drilled and blasted out of solid lava rock for that purpose. There, telephone, radio and messenger communications are centered and gages show pressures at various control points (Fig. 3).

Surveying instruments at lookout stations at high points throughout the city enable the administrators at the control center to locate centers of trouble. The topography of Honolulu lends itself to this system of reporting and control, hills back of the city supplying the elevations necessary to give the lookouts an unobstructed view in nearly all directions.

Communications are also maintained between the control center and the widely scattered water works installations, with other utilities, with the Office of Civilian Defense, with the Army authorities and with the local police and fire departments.

Co-ordination of Utilities Activities

Co-ordination of utilities activities for emergencies has been effected by Colonel Roy M. Foster of the United States Engineer Department. As soon as the Japs struck, the U.S.E.D. called all utilities heads into consultation and it was agreed that war requirements should be met, insofar as was possible, by augmenting existing services and their operation under

conditions that would remain as nearly normal as the circumstances permitted, and without interference with the civilian management. On its part the U.S.E.D. undertook to establish and maintain pools for the storage of reserve equipment, materials and supplies, and arrangements were made for the establishment of a reserve labor pool on which the utilities can draw in emergencies. The labor pool is a particularly valuable contribution.

The U.S.E.D. then set up a central utilities control for emergencies and has provided for supervision of right of way priority and co-ordinated co-operation during attack periods.

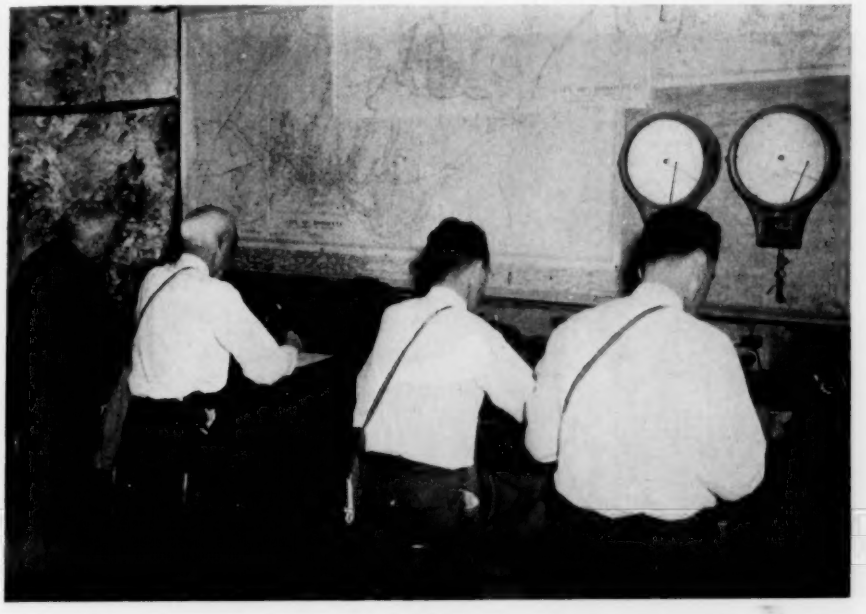


FIG. 3. Subterranean Control Center; showing maps, pressure gages and telephone battery

Employee Preparations

Throughout the year preceding the war and since, employees of the Board of Water Supply have been systematically prepared for war emergencies. Recognizing that valve control is the most important activity under attack conditions, most of the male employees in the personnel have been trained in that work to provide qualified emergency reserves for the maintenance crews. Manholes, which are left unsealed for ready accessibility, and valves have been painted with symbols that are informative to regular crews and their emergency helpers for the purpose of saving time

and avoiding confusion under stress. Practical training in the field is being given continuously to the men who will handle the valves. Air raid wardens, volunteer firemen and others outside the water works have been emphatically warned not to tamper with valves, except under the direction of a qualified water worker. The only pipe line break in the December 7 attack was caused by inexpert handling of a valve.

Immunization against typhoid and smallpox was carried out on a voluntary basis by Board of Water Supply employees in 1941, months before the whole community was called upon to take like precautions under a military order.

FIG. 4. Gas Alarm at Employees' Assembly

Lectures on first aid, incendiary bomb control, gas attack defense and decontamination, nutrition and allied subjects were started during the preparedness period and have been continued since. Employees assemblies are held from 2:30 to 4 P.M. one afternoon each week and special classes are trained and drilled at regular intervals.

Because of the advanced stage of preparedness of water works employees, they were issued gas masks by the Army early in the war, the remainder of the community being served later. The masks were issued on December 24 and, early in January, officers of the chemical warfare service began to

drill the water workers in their use and instructed them in gas defense and decontamination methods (Fig. 4). An interesting suggestion which developed out of the gas lectures and mask drills is that practice with the masks be deferred until the close of the talks. Otherwise hair disarranged by mask straps is likely to engage more attention among women employees than do the words of the instructor.

Employees are not warned in advance of air raid or gas alarms and do not know until the drill is completed whether an alarm was genuine or practice. This is in accordance with general alarms in Hawaii under military government—the public being instructed that *all* alarms are genuine. The military authorities *do not* sound *practice* alarms.

L. T. Bryson, staff chemist for the Board of Water Supply, designed gas first aid kits in two types that won high commendation from Colonel George F. Unmacht, department chemical warfare officer. Colonel Unmacht reports that the Bryson kits, with minor modifications, have been adopted for use throughout civilian defense activities in Hawaii. The large "A" type kits are portable but are designed for semi-permanent location at gas first aid stations. Smaller "B" type kits are designed for use on vehicles by crews in the field. Detailed descriptions of these kits, rules for their use and the form of gas casualty report worked out by Mr. Bryson are given in the Appendix, p. 1157.

Defense Training for Employees

Regular squads of employees have been organized to serve as fire wardens, first aid workers, gas first aid workers, decontamination crews, demolition crews and for guard duty. Men and women employees have been drilled in the handling of incendiary bombs and have been encouraged to train the members of their families. The activities of these crews are confined to in and around the water works. Employees have been discouraged from enrolling for outside war activities.

Training has been extended into the employees' homes in other instances where wives of the workers have shown an interest. Among the activities in this category have been Sunday morning demonstrations in nutritional values of local foods.

Red Cross first aid training and gas first aid are regarded as fundamental requirements for all employees and courses in them are well advanced. The individual must be prepared to care for himself in emergencies.

Protection of the water supply at its sources does not present a major problem in Honolulu. It is virtually impossible to contaminate the artesian areas and the mountain sources and surface reservoirs are regularly inspected for evidences of tampering. Of course there is no way to obtain complete protection of the pipe line system from contaminators' sabotage,

but increased precautions are being taken by the bacteriological and chemical staffs who make daily tests that cover the entire system. Cooperation in this work is being given by the laboratory staffs of the Territorial Board of Health and the University of Hawaii.

Decentralization of Vehicular Equipment

Decentralization of the vehicular equipment was one of the first precautionary measures taken by the Board of Water Supply. A few hours after the Japs struck on December 7, plans had been completed for safeguarding the water works rolling stock, which hitherto had been assembled

FIG. 5. Board of Water Supply Drivers Dispersing Vehicles to Places of Comparative Safety at Sounding of Air Raid Alarm

at night in a central transportation yard at headquarters. Crews were reorganized according to the neighborhoods of their residence and were given night custody of the equipment their work requires. Under this plan, at night, Board of Water Supply trucks, compressors, shovels, hoists and passenger cars are distributed throughout Honolulu in readiness to go into action at once in the areas most likely to suffer from attack. This plan had added somewhat to the cost of operation but that is offset by the security afforded. There is no danger of the cars being used for personal purposes, for under the blackout and curfew they cannot be on the streets after dark unless they are on an official errand.

Lights on all vehicles have been blued out, with a 2½-inch bullseye of lighter blue for safety in operation. A night speed limit of 20 mph. is rigidly enforced under order of the Military Governor.

Vehicles of a selected group in each utility have been marked with a white patch one foot square on the left front fender. This marking gives the car right of way through all lines into "blitzed" areas during an attack.

In addition to dispersing the vehicles at night, drivers and crews are trained to take their equipment to scattered points of comparative safety when a raid alarm sounds at a time when they are assembled at the head-

FIG. 6. Subterranean Bomb Shelter; showing part of the 400 ft. of tunnel in one of ten compartments which include two escape tunnels and a gas chamber; note concrete meter boxes which serve as seats

quarters' yard (Fig. 5). Drills show that the men can disperse their vehicles and return to safety in the bombproof control center shelter (Fig. 6) within five minutes from the time an alarm sounds.

The water works is on semi-alert at all times. Dormitory provisions have been made at the Board of Water Supply building so that at least one executive can be available there every night. Eight beds have been provided for this group, each executive having his own to occupy once in eight days. This arrangement rotates the night of duty for each man so the same one does not have to remain away from home every Saturday or Sunday night.

After the underground control center and employee shelter had been completed, work was begun on two underground storage chambers, adjacent to outlying units of the water works, where maps, records, and valuable supplies can be protected from destruction in an attack. This rock work is being done by water works crews who have been trained in hard rock mining by experts who were brought to the Territory for defense and war jobs. This training has been given the water works men with a view to post-war operations which will include the drilling of infiltration tunnels in the hillsides above the city, a project that was interrupted in its early stages by the Jap attack.

Personnel Problems

One of the most perplexing problems the water works confronts involves personnel. With the cost of living skyrocketing and war pay levels prevailing on emergency construction jobs it is difficult to persuade government employees that job security, vacation and sick leave and retirement allowances are sufficient to offset immediate differences in compensation. The Military Governor has frozen all employees in their jobs and at their normal pay, but it takes administrative ingenuity to maintain morale under existing conditions. Fortunately, the majority of employees of the Board of Water Supply have been long in service and are exceptionally loyal. Despite this fact the board lost a large percentage of its trained men before the freeze order was issued. It is difficult to convince a workman that he is better off on a steady job at from $112.50 to $137.50 a month than is his roommate who is making about that much a week on a war job.

Consumer Education

Paradoxically, a reputation for reliability of service for which the Board of Water Supply has worked ceaselessly during the past seventeen years has now become one of its most vexing problems. Because the public has come to believe it can rely upon its water supply, the board is having a difficult time trying to convince the people of the necessity of keeping on hand at all times a supply of water for fire fighting and domestic use if there should be no water in the mains, but it is engaged in a continuing campaign to that end.

It has been Board of Water Supply practice to enclose mailers—called Information Slips—with its monthly bills. These are prepared carefully with topical interest that makes them widely read. In this emergency they have been particularly valuable in getting across messages that have aroused public interest in preparedness and war efforts. The latest slip is illustrated with two overturned buckets and bears the caption, "Empty Buckets! Will Not Save You If There's No Water In The Mains!" It

tells of the fall of Hongkong, Rangoon, Batavia, Singapore and Corregidor after failure of the water supply and urges the necessity for keeping on hand a household water supply for emergencies.

CONSERVE WATER

Unsung Heroes of the War of London

In modern war one of the most important items of ammunition is water.

This significant statement is made by John H. Cosgrove, who has written a thrilling booklet, "The Fireman's War," dedicated to the courageous 30,000 men and 5,000 women of the London Auxiliary Fire Service. The booklet, illustrated with photographs from Life Magazine, is copyright 1940 by the American Reserve Insurance Company.

Mr. Cosgrove tells how England foresaw the necessity of adequate water supply and modern fire fighting equipment as early as 1935 and, when the war started four years later, had men and women sufficiently trained to aid the regular fire fighting force in its stupendous task of defeating the Nazis' repeated attempts to destroy the city by fire. He contrasts graphically the preparedness of London to combat the fire demon with conditions that prevail in the United States. American unpreparedness was illustrated at a recent international convention of fire chiefs at Spokane, Washington, which reported:

> "Practically all of the existing manpower, fire fighting equipment and signalling systems of the fire departments of the United States are woefully inadequate."

The fire chiefs urged that America follow the example of England and organize an auxiliary fire fighting service as a means of lifting the scourge of fire and reducing to a minimum the terrifying toll of human lives and economic resources the red marauder claims each year for its own.

Aware that the water supply is the basis of fire defense, England, long before the crisis came, had registered every water source, making an official record of streams, lakes, ponds, and even every swimming pool in clubs, hotels and elsewhere. Pipelines were run to strategic points throughout the city, millions of feet of extra hose, and emergency pumps, ranging from the small trailer-type, delivering 100 gallons a minute, to larger ones, with a capacity of 1,000 gallons, were purchased and placed at the disposal of the fire fighters.

The most effective general weapon for conquering incendiary bombs, Mr. Cosgrove found, was the Stirrup Pump, resembling a bicycle pump adapted to water instead of air. The spray from these little hand-and-foot pumps speeds up the burning of the incendiary bomb and causes it to burn out quickly but does not provoke an explosion, such as might be caused from a heavy stream of water on the bomb's chemicals.

The London Auxiliary is completely organized, its operations being directed methodically from a central bomb-proof control room. Its volunteers are on the most hazardous duty imaginable, day and night, braving bombs and machine gun bullets and death from falling walls or by suffocation, they work without thought of glory; their heroism is magnificent.

The British, at horrible cost, will emerge from the war a water- and fire-conscious people. Will America profit from the lesson?

Your Board of Water Supply is doing what it can towards contributing its share to preparedness for National Defense. It has taken important steps for the protection of the Honolulu water works system, and has under way a development program through which it is expected to add appreciably to the city's artesian water reserve. This will be done through conservation of surface mountain waters and their infiltration into the artesian areas. Normal growth of Honolulu would require this and other developments eventually, and the work has been carefully planned and prepared for. The present emergency has served to advance the time schedule for this important phase of the defense of Honolulu.

BOARD OF WATER SUPPLY

"At your service 24 hours in the day"

City Hall **Telephone 6201**
February 1, 1941 **P. O. Box 3347**

PURE WATER—MAN'S GREATEST NEED

[PLEASE SEE OTHER SIDE]

PURE WATER—MAN'S GREATEST NEED

CITY water bills payable to "Board of Water Supply"
RURAL water bills payable to "Rural Water Works"

[PLEASE SEE OTHER SIDE]

FIG. 7

Another "Information Slip" supplemented newspaper and radio publicity required to combat rumors of water contamination. These rumors began almost simultaneously with the arrival of the Japs, although investigation failed to indicate that they arose from planned sabotage. During the

CONSERVE WATER

WAR NOTICE TO WATER USERS

Know how to shut off water service at your premises.

If you know where the **control valve** is, make certain that it is in working order.

If you do not know where it is, find out at once.

If you are unable to find the valve, fill in and mail us the enclosed Post Card. No stamp is needed.

Do not telephone for this information.

It may be necessary to cut water service off from your premises quickly to prevent property damage from a broken pipe. If you do have to turn off your water, do not be alarmed. Service will be resumed as quickly as repairs can be made.

You can shut off the water easily and quickly if you know where the control valve is located, and if it is in good working order.

This is vital to public safety. A broken pipe will reduce pressure in the water mains at a time when pressure must be maintained for fire protection.

Do not delay. Keep calm. Act now.

Be prepared.

Do your bit.

BOARD OF WATER SUPPLY

"At your service 24 hours in the day"

City Hall **P. O. Box 3410**
December, 1941

CITY water bills payable to **BOARD OF WATER SUPPLY**
RURAL water bills payable to **RURAL WATER WORKS**

FIG. 8

PURE WATER—MAN'S GREATEST NEED

TELEPHONE

In *All* Water Emergencies Day or Night

If you have good reason to believe the water supply has been tampered with—telephone 6201.

If a pipeline is broken in your neighborhood—telephone 6201.

If you see prowlers around a water works unit—telephone 6201.

Don't get panicky! Keep a cool head.

Vital units of your water supply are well guarded and under constant supervision. There is little danger that the supply will be tampered with. But be on the alert. We want your help.

If anything goes wrong we will notify you!

Don't let idle rumors scare you.

Rumors are enemy weapons. Don't help them use those weapons.

Telephone 6201 in *all* water emergencies.

BOARD OF WATER SUPPLY

"AT YOUR SERVICE 24 HOURS IN THE DAY"

PURE WATER—MAN'S GREATEST NEED

FIG. 9

PURE WATER — MAN'S GREATEST NEED

EMPTY BUCKETS

Will Not Save You If There's No Water In the Mains

Hongkong! Rangoon! Batavia! Singapore!

At each the same tragic story—no water in the mains, and the cities fell!

Five days without water at Corregidor—then surrender!

There was food. There was ammunition. There was the will to fight.

But there was no water!

Disease stalked the ranks of the defenders.

Fires swept unchecked.

There was no water!

Honolulu's artesian water supply, stored safely underground in Nature's bombproofs, cannot be destroyed.

But that does not make Honolulu safe from water shortage under enemy attack!

(Over)

When Bombs and Shells Fall!

If the city's water works were to be destroyed; if its water mains were to be demolished; the artesian water supply would remain intact far underground—*but it could not be distributed where it would be most needed!*

It could not be delivered to your home or your place of business to fight fires, to quench the thirst of persons held prisoners in their shelters during a raid, to keep the sanitary system of the community in operation.

That is why the Board of Water Supply gravely warns the people of Honolulu not to rely upon uninterrupted water service in war emergencies.

That is why it is the duty of every householder to keep on hand at all times supplies of water for drinking purposes and for use in fighting fires.

It is not humanly possible to safeguard a water works system from disruption by war. There are 325 miles of pipelines spread throughout Honolulu. There are pumping plants and reservoirs. Any or all of these installations might be destroyed by bombs or shells. There is no way in which they can be given absolute protection.

If mains and other installations are damaged, your Board of Water Supply will restore service as soon as that can be done; but *only you can supply the protection you need* by providing in advance water for drinking and for fire fighting.

We will serve you to the best of our ability —but don't take chances!

BOARD OF WATER SUPPLY

"At your service 24 hours in the day"

Honolulu, T. H. P. O. Box 3410
June 1, 1942 Telephone 6201

● CITY water bills payable to **BOARD OF WATER SUPPLY**
● RURAL water bills payable to **RURAL WATER WORKS**

FIG. 10

morning of December 7, a group of boys ran through the streets of one residential district shouting, "The water has been poisoned." One woman, who had just taken a drink of water, became so alarmed she fainted. Others were hysterical. Another false alarm was caused by an outbreak of typhoid which was quickly traced to a carrier. The water supply has remained uncontaminated.

As early as May, 1939, the board began devoting "Information Slip" mailers to national defense. In that month it sent out calls for the first practice blackout in Honolulu. Some of the subsequent slips have been:

May 1940—*Notice of second blackout practice*

February 1941—*Unsung Heroes of the War of London*, telling of the work of the firemen and water workers there (Fig. 7)

April 1941—*First Aid—For Your City Water Service Troubles*, emphasizing the Board of Water Supply telephone number for use in emergencies

May 1941—*Notice of third blackout practice*

August 1941—*United States Defense Savings Bonds*

September 1941—*What Happens to Water Service Under Bombardment*, telling of the lessons taught at Coventry and elsewhere

October 1941—*Major Disaster Council*, notifying the public that evacuation forms are being sent out

December 9, 1941—*War Notice to Water Users*, accompanying a Business Reply Card and urging householders to find the water control valve on their premises and make sure it is in working order, offering information and assistance if required (Fig. 8)

January 1942—*Telephone 6201 in All Water Emergencies, Day or Night*, with description and illustration of simple blackout ventilation device for double-hung windows (Fig. 9)

January 15, 1942—*List of First Aid Stations*, with addresses and telephone numbers, and directions as to what to do under attack

March 1942—*Your War Garden*, hints for amateurs

March 15, 1942—*Put Some Blood in Safety Deposit*, a plea for blood plasma bank, illustrated with a sketch adapted, by permission, from New York City's drought campaign

April 1942—*Girl Identified As Typhoid Carrier.* Newspaper quotation to check rumor that water supply was source of incipient typhoid epidemic and quotations from Rosenau on typhoid. Illustrated with cartoon by Moran, U.S. Army Intelligence, *"You've Blacked Out Your Rooms, Now Blackout Your Rumors."*

May 1942—*Summer Gardens*, further hints for war gardeners

June 1942—*Empty Buckets* (Fig. 10).

These slips have caught the public fancy and extra runs have been made of several of them by agencies that wanted them for use as handouts.

Appendix

Gas First Aid Kits—Type A

Number of kits prepared—8

DESCRIPTION:

A. *Container:* A wooden box measuring $15\frac{1}{2}$ x $11\frac{1}{4}$ x $11\frac{1}{4}$ in. outside dimensions, provided with a hinged lid and hasp, without lock. Interior of box has a partition to separate two classes of equipment.

The container is painted black inside and out and on the lid is marked "B/WS Gas First Aid Kit No.—"

B. *Contents:*

1 qt. *Bottle A*, a wide mouth jar containing chlorine solution, 0.6 per cent available chlorine*
1 pt. *Bottle B*, liquid soap
1 pt. *Bottle C*, sodium bicarbonate 10 per cent solution
1 pt. *Bottle D*, copper sulfate 7 per cent solution
1 Atomizer (nose and throat) for solution *C*
1 Eye dropper for solution *C*
1 Eye cup
1 pr. Forceps
1 pr. Scissors
1 pr. Gloves, canvas
30 yd. Bandage, roller, 2-in.
—Bandages, triangular
1 lb. White waste (separated into suitable wads)
20 Gas casualty report forms (Fig. 11)
1 Pencil
1 pc. Carbon paper

C. *Instruction for use:* Attached to inside cover of each container, as follows:

NOTICE: This equipment is for WAR GAS CASUALTIES ONLY, and may not be used for any other purpose.

Gas First Aid Treatment Instructions

Preparation: When either a general or a local gas alarm is heard, the first-aider must put on and adjust his gas mask, and protective clothing if available. Lids and corks of all bottles in this kit should then be loosened. The pair of gloves should be thoroughly wet with chlorine water,

* For composition of this and the following solutions, see "Solutions for B/WS Gas First Aid Equipment," p. 1161.

GAS CASUALTY REPORT

Name .....

Identification No. .....

Received at ..... Station,

date ....., time .....

First aid completed,

date ....., time .....

Dispatched to hospital,

date ....., time .....

Suspected nature of gas .....

Duration of exposure,

hours ....., minutes .....

First aid treatment given: (check items)

Splashed liquid removed
Treated for phosphorus burns
Chlorinated water on burns only
Chlorinated water on entire body
Liquid soap applied to burns
Soap and water bath given
Burns dressed with 10% soda
Eyes, nose and throat bathed with 10% soda
Hot coffee given

Date ..... (Signed) .....
Operator

FIG. 11

Bottle A. The following steps must be performed rapidly but carefully, in the order given. Immediately on receipt of a gassed casualty, put on the gloves.

Step 1. Take up any splashed liquids on face, hands or arms of casualty with wads of dry waste. Use waste like a blotter. Do not rub or wipe. Throw away the used waste, and repeat if necessary to remove all liquid, using clean waste.

Step 2. Sponge these splashed parts with waste wet from *Bottle A*. Do not rub or wipe. Repeat once using clean waste wet from *Bottle A*.

Step 3. Sponge these parts with waste wet from *Bottle B*, and leave this soapy water in place on skin of casualty, without rinsing off.

Step 4. If casualty has particles of burning phosphorus on skin or clothing, put out these fires by sponging with or pouring on contents of *Bottle D*.

Step 5. Take patient to bathroom and quickly remove all clothing. Take off your gloves and bathe patient with very soapy warm water. If the casualty is unable to stand, sponge off entire body with soapy warm water on a stretcher. Rinse with warm water (*not cold*).

Step 6. While wiping dry, examine body rapidly for inflamed or burned spots. Apply to these spots clean waste saturated from *Bottle C*, and fasten in place lightly with a loose bandage.

Step 7. Remove with the forceps any visible pieces of phosphorus from the skin.

Step 8. If face of casualty was exposed to gas, wash nose, throat and eyes with contents of *Bottle C*, using the spray atomizer, eye dropper and eye cup. Do not rub or bandage eyes, but flush repeatedly with this solution.

Step 9. Dress with clean clothing, lay patient on stretcher, and cover with blankets. Give hot coffee if available, unless an ambulance is ready to remove the patient immediately.

Step 10. Make out a gas casualty report in duplicate, taking care to check all the items of first aid treatment which were given.

Step 11. Send patient to hospital with one copy of the report as soon as ambulance arrives. Do not allow patient to get up and walk.

General Rules

Rule 1. The first aid operator placed in charge of this kit is required to read these instructions and to make sure he understands them. He will also be held responsible for the contained equipment.

Rule 2. This treatment must be given to all employees coming through or found in any gassed area.

Rule 3. Board of Water Supply employee casualties will have precedence over non-employees.

Rule 4. Casualties who are both gassed and injured will be dealt with by the gas first aider and the Red Cross unit operator jointly.

Rule 5. If casualty has no liquid splashes or phosphorus burns, the treatment begins with *Step 5*.

Rule 6. Contaminated clothing will give off gas and must be promptly removed from bathroom for decontamination, using the gloves for such handling.

Rule 7. Gloves may be decontaminated after each casualty by saturating again from *Bottle A*. Do not place gloves in the bottle. Pour out on the gloves.

Rule 8. Used waste must be destroyed either by burning or burying as soon as circumstances permit.

Rule 9. The spray atomizer and eye dropper bottle may be refilled from *Bottle C*.

Rule 10. *Bottles A, B, C* and *D* when empty must be returned to the Chemical Division for refilling.

Gas First Aid Kits—Type B

Number of kits completed—35

Number of kits in preparation—48

This is a portable type of kit designed to be carried in the dash compartment of cars.

DESCRIPTION:

A. *Container:* A heavy cardboard box measuring $8\frac{1}{2}$ x $5\frac{1}{2}$ x $3\frac{1}{2}$ in. inside dimensions, provided with a slip-on cover.

The cover bears a label marked "B/WS Gas First Aid Kit Type B, Car No. —"

B. *Contents:*

1 8-oz. jar soap ointment *a*

1 8-oz. bottle copper sulfate, 7 per cent solution

6 oz. White waste (separate into suitable wads)

C. *Instructions for Use:* Attached on inside of cover, as follows:

NOTICE: The main purpose of this kit is to enable you to remove splashed blister gas from exposed skin surfaces without delay.

Liquid war gases on your face, hands or arms must be removed and the last traces destroyed very quickly, within one minute if possible. Prompt action in following the "Instructions" may save you severe disabling burns and subsequent poisoning.

If you have been exposed to gas shell bursts or airplane spray, you must carefully examine yourself and apply this treatment at once, even to the smallest visible drops.

Instructions

FIRST: Take up all liquid drops or splashes by mopping up with dry waste. Use the waste like a blotter. Do not rub or wipe. Throw away the used waste and repeat until all liquid has been removed, using a clean waste wad each time.

SECOND: Quickly smear a thick coating of the soap ointment on all affected parts, rubbing in just enough to insure contact with the remaining traces of liquid blister gas. Leave the ointment in place, without wiping or washing off.

THIRD: Proceed to nearest hospital or first aid station immediately. Application of this treatment will *not* enable you to remain on duty.

Use the copper sulfate solution to put out any phosphorus fires on skin or clothing. It may be poured on or applied with waste dripping wet with this solution.

CAUTION: The Soap Ointment contains a strong alkali. Do not get it in your eyes.

Inspected———— By————

The following slip is placed loose in the kit, for the attention of the user.

This kit is to be considered as part of the equipment of the car to which it is assigned. It may not be removed from the car except in case of real emergencies.

The driver who signs for this outfit is expected to keep it ready for immediate use and to take appropriate care of it. He is furthermore required to read and make sure he understands the notice and instructions on the inside box cover.

Issued by the Chemical Division,
Board of Water Supply, May 23, 1942

Solutions for B/WS Gas First Aid Equipment

Type A Kits:

Bottle A, chlorine water, make up according to the available chlorine product:

Available product	*Use for 1 qt.*
H.T.H.	1 heaping tablespoon
Bleaching powder	2 heaping tablespoons
Clorox	½ pt.

Mix with sufficient tap water as above. Keep corked and in a cool place. Requires replacement in three months.

Bottle B, liquid soap. Made from liquid soap manufactured by Hilts Laboratories, as follows:

Liquid soap	3 qt.
Water	1 qt.
Washing soda	3 oz.

The washing soda is dissolved in the water before mixing with the liquid soap.

Bottle C, soda solution. This is *baking soda* (bicarbonate of soda), 2 tablespoons in 1 qt. of water.

Bottle D, copper sulfate, dissolve 1 tablespoonful in 1 qt. of water.

Type B Kits:

Soap ointment *a* is made up as follows:

Holo ka Hana chip soap	1 lb.
Water	3 pt.

Dissolve the above and add:

Washing soda	12 oz.
Water	$1\frac{1}{2}$ pt.

This has a pasty consistency and is put up in ointment jars.

Copper sulfate solution is made up in same manner as for Type A Kits.

Guarding Water Works Property

By Warren J. Scott, Harry U. Fuller and W. W. Hurlbut

Connecticut—Warren J. Scott

A SUPERVISORY official in one state can hardly attempt to set down any general guiding set of rules to be followed in guarding water works property. It might be of interest, however, to discuss the subject in the light of some of the problems encountered in Connecticut, a highly industrialized area.

A letter on the subject of protection was forwarded to Connecticut water works officials by the Commissioner of Health, as long ago as June 20, 1940. At about the same time the Connecticut Public Utilities Commission detailed its engineer to visit each utility in the state to discuss measures for protection of water supplies; and in December 1940, a defense committee of the Connecticut Water Works Association was appointed and actively co-operated with the state agencies. The State Police Commissioner met with the committee on December 18, 1940, and outlined protective steps. Many of the steps recommended by state agencies were begun or completed in 1941.

When war commenced, the Governor discussed with the Public Utilities Commission and the State Police Commissioner the guarding of public water supplies, and a co-operative program was worked out, whereby each utility in the state was visited jointly by representatives of the Public Utilities Commission, the State Police Department and the State Department of Health. Recommendations for additional protective measures were then drafted and these recommendations were forwarded to the utilities several months ago.

A symposium presented on June 23, 1942, at the Chicago Conference by Warren J. Scott, Director, Bureau of San. Eng., State Dept. of Health, Hartford, Conn., Harry U. Fuller, Chief Engr., Portland Water Dist., Portland, Me., and W. W. Hurlbut, Asst. Chief Engr. & Gen. Mgr., Bureau of Water Works & Supply, Dept. of Water & Power, Los Angeles.

In Connecticut privately owned water utilities far outnumber those municipally owned, although many of the large supplies are included in the second group. Even though the utilities commission did not have the power to enforce its recommendations upon municipal governing bodies, excellent co-operation was evidenced in general and it is believed that Connecticut compares favorably among the states in carrying through protective measures for water supplies. A few private companies asked for a review of the recommendations because of costs or other questions. Such reviews were made, resulting, in some cases, in minor modifications.

The costs of added expense have been met by the utilities, usually without protest, although in one or two instances the additional costs may be submitted as supporting evidence of the need for increased rates. It is unlikely that rate cases will be inaugurated entirely on the basis of protection costs. A surcharge above existing rates for the duration of the war has been adopted in Connecticut in one case where industries affected were ready and willing to assume a portion of the cost of protection. This assumption of some surcharge by benefited industrial properties seems a fair arrangement to handle necessary policing costs which would otherwise be extremely burdensome for small utilities.

Purpose of Protective Measures

Protective measures are designed to cope with sabotage and fifth column attack. Of greatest concern is possible damage to structures, although danger from use of poisons cannot be entirely dismissed. Sabotage *by the enemy* is the most apparent danger, but damage by cranks in these upsetting times is also a possibility. The big job is to win the war and this means that, in the field of water supply, time and money are best spent on water supplies that contribute substantially to the war effort. This calls for special attention to those supplies providing water to war industries and military establishments as well as to communities housing industrial war workers, with somewhat less concentration on entirely domestic supplies to homes in places where, despite the occurrence of inconvenience due to water supply interruption, there would be no decided set-back to the war effort. This weighing of the importance of the water supply must be an essential factor in consideration of costs.

The federal authorities have announced that the general assignment of troops to guard all utilities is not feasible. It has not appeared practicable, in most states at least, to designate state troops for the duty. Local and state police may frequently co-operate, but the job for the most part rests with the water utility management and it has been impressed on water works men by the Army that water utility managements are held strictly accountable for laying adequate plans to keep water supplies functioning.

It serves no useful purpose to "grouse" about heavy financial burdens and do nothing. If the essential water supplies are not kept going, the war may be lost and ownership, dividends and all that goes with them, lost too. What seems most necessary is to evaluate protective steps, to take all reasonable measures that are agreed upon as necessary by supervisory authorities, and to see that the maximum amount of protection is obtained for each dollar spent.

Structures and Outside Properties

Many protective measures for water plant structures are a good investment—war or no war. There is always the danger of the crank or the careless trespasser.

Protection of buildings includes window guards, steel doors in lieu of wooden doors, and fencing. Many utilities in Connecticut have installed an especially heavy wire guard in windows of gate houses, filtration plants, pumping stations and chlorinator houses. Such heavy wooden doors as may not be replaced have been equipped with pin tumbler locks instead of a plain padlock. Many utilities have installed "non-climbable" chain link fencing around vulnerable spots such as pumping stations, chlorinator houses, filtration plants and the like. Fences in some cases have been erected around the ends of dams to prevent access. One value of a strong fence is that even if it can be surmounted, a guard knows that a person seen on the wrong side can be regarded as a suspect.

For property outside of buildings, manhole covers over clear wells at filter plants have been locked, valves and gates have been locked and fences have been built. Manhole covers have been protected by securing flat iron bars on either side and locking them. Special bolts have also been used. Where valves and gates are in exposed locations, e.g., where gates are not inside gate houses or are on top of clear wells, they have been pin-locked. In some instances the wheel of the gate has been removed.

Some utilities have cleared away brush and cut off lower growths of evergreen trees so that land in the vicinity of dams, reservoirs and treatment plants can be kept under ready surveillance. Floodlighting of dams, of property near highways which is readily accessible, of filtration or chlorinating plants and of pump houses has been widely used. Sometimes this floodlighting is continuous; in other cases it has been used intermittently after installation. Posting of signs has been extended to keep away unwanted visitors and photographers. Signs that call attention to water supply properties have in some cases been changed to read only "No Trespassing," where this has seemed advisable. Where armed guards are stationed, the signs frequently read:

WARNING—DANGER
No Trespassing
Armed Guards in Control
Name of Utility

Full use of protective measures for structures aside from policing has two advantages: (1) they frequently are desirable betterments to plant properties and thus constitute an investment for the future and not just an expense; and (2) they supplement policing and thus often permit reduction in expenditures for policing.

Policing

In commenting on the employment of police, the writer's remarks are based simply on the analysis of recommendations by police authorities in his own state.

Many regular water works employees have been deputized by the state police department as special policemen with power of arrest. The need for careful selection of police personnel has been stressed. The State Police Department has agreed to investigate for water companies and municipal water departments the background of candidates for police jobs, with a view to eliminating those who are not reliable. The state police, by their roving patrols, also exercise some degree of supervision over special policemen and endeavor to get rid of the types who may go to sleep or become intoxicated while supposedly on the job. Guards should receive training and should be given definite instructions. Some utilities have established training courses in the use of weapons, including target practice. In one case in the last war, a guard, without good reason, shot and killed a person, for which the municipality paid heavy damages. This example illustrates the need for selecting guards who are likely to exercise good judgment after training.

Full-time reliable police in adequate numbers may be required for important locations. The expense, however, is sometimes a complication, especially in the case of small utilities where the annual cost of one or two police beats manned for 24 hours might exceed the annual revenue. To supplement police at special points, roving patrol by police officers is often used. Two-way radio and telephone communications are frequently included in the set-up. Attendants at pumping stations or filter plants in outlying districts may be required to telephone another station or the local police at regular intervals so that, if anything happens to the attendant, help will be dispatched promptly

For non-motorized police assigned to stationary beats, small guard houses are usually erected, many of which are equipped with telephone and

radio. All police appointed by the water utility should be under adequate supervision of a responsible employee.

Should attack by a fifth column develop, guards of themselves might not prove adequate to fend off attack but might be in a position to fight a delaying action until help could be summoned.

Value of Guarding

This raises the question of whether guarding as practically administered is of value mainly for the protection of property or principally for bolstering public morale. It goes almost without saying that it may be an expensive way of bolstering public morale if that is all it is good for; but guarding, if intelligently planned and ably administered, is worth while in the protection afforded. The latter is the real criterion of its value. Extravagances are to be avoided, of course. Full use should be made of such permanent protective measures for property as may reduce the need for policing. Roving patrol, and communications between stations and patrols, should be fully used to supplement, or in some cases as a substitute for, the stationing of permanent guards.

Opinions are bound to vary widely as to the need for, and desirable extent of, guarding water works property. It is believed that competent police authorities, whether state or local, will be willing to advise water works officials on policing problems, and, in certain cases, the Army authorities in the district may be willing to advise on protection of important properties.

It should be stressed that each water works management is held responsible for the operation of the local system. The fact that a guarding system will not be 100 per cent perfect should not lead to the conclusion that a plant might as well take a chance on no guarding. It is true that guarding may be overdone, but failure to carry out what appears to be a reasonable program of protection lays the water utility management open to justified criticism if something happens. Guarding is only one part of the protection program. In evaluating such programs, financial considerations should not be dismissed too lightly, but it must be remembered they will be of little moment if we lose the war. Based on reports of serious consequences from disruption of water supplies carried out along with enemy action in the Pacific theater of war, someone recently proposed the slogan that we all should remember, "Water Wins Wars."

The writer wishes to thank the Defense Committee of the Connecticut Water Works Association, Joseph P. Wadhams, Engineer of the Public Utilities Commission, and the Connecticut State Police Department under Commissioner Edward J. Hickey, for data furnished.

Portland, Maine—Harry U. Fuller

A WATER works that furnishes water for direct war use such as to forts, shipyards, air fields, and to factories turning out war supplies, is of vital importance to the war effort, and every effort should be made to insure its continuous service. When the water supply fails, many war activities stop.

As the war progresses and perhaps comes closer, the guard problem will change. Every operator should keep his mind open and do such guarding as seems to be justified. Every water works is a problem in itself, not exactly like any other so that the only generally applicable rule is that everything reasonably possible should be done to insure a continuous supply.

Guarding a water works property is a partial insurance of a continuous supply. Part of the cost can be considered insurance, but there is a value too in the effect on the public morale. The public seems to believe that guarding is justified where sabotage might be expected and where the results might be serious.

What to Guard

The question of what part of a water works to guard can be answered by balancing the cost of guarding and its probable effectiveness against the probable loss to the water users from an interruption of service. It would seem that such vulnerable points in a water system as head works, pumping stations and filter plants, where damage by a saboteur might cause a long interruption of service and which could be reasonably fenced and floodlighted might be guarded. Mains, whether in the country or in streets, can generally be repaired in a reasonably short time and no attempt to guard them would be effective.

Guarding is some protection against a saboteur, and the protection is increased if the guard is inside a fence and if floodlights are available in an emergency. Floodlights should be used to light up the area outside the fence but should leave the guard in the shadow and should be turned on only to determine the cause of a suspicious noise.

It is the experience in Maine that neither Army, police, nor civilian defense personnel is available to guard water works property, so that each utility must do its own guarding and pay its own cost.

In Portland, Me., the water works personnel has been organized to make quick repairs and is not enrolled in any other civilian defense activities. Four points seem sufficiently vulnerable to justify fencing, floodlighting, telephone connection and guarding: two intakes on the shore of the lake

furnishing the water supply, a chlorine plant through which all water flows and an emergency booster pumping station.

The personnel consists of a foreman of guards and seventeen men. The guarding is carried on in three eight-hour shifts, the foreman keeping no regular hours but checking the men at irregular intervals. During daylight hours one guard is on duty alone, but at night two men work together. The most vulnerable place is also the most isolated, so that there the guards work in pairs all the time.

A watchman's clock is of great assistance in keeping the guards alert and in motion. The clock keys are located at strategic points and the guards are required to punch the chart sufficiently often to keep them moving.

The guards are middle-aged men not likely to be called for military service and live reasonably close to their stations. They are paid $4 for an eight-hour shift, total cost amounting to about $30,000 yearly. This amount is equal to an annual cost of 25 cents per capita or 4.5 per cent of the gross income.

The success of a guarding job, like the success of a construction job, depends very largely on the ability of the foreman. He should be selected carefully and given the authority to hire and fire his men.

Only water works that supply water to direct war activities should employ guards, and then only on particularly vulnerable points where damage could not be quickly repaired.

Conditions will change during the progress of the war and guarding should keep in step.

Efficiency is increased by fences, floodlights, telephones and watchmen's clocks.

Every water works is a problem in itself, the only general rule is to keep water flowing.

Los Angeles—W. W. Hurlbut

IN THIS emergency, water works men on the Pacific Coast have a particularly critical and important problem in the adequate protection of its water works systems. Especially is this true of the Bureau of Water Works and Supply of the city of Los Angeles, because of the large territory and civilian population it serves and the vital war industries located within its area.

In November 1933, the Major Disaster Emergency Council was created by city ordinance and by it was established a complete organization and plan for action to deal with events which might develop to disrupt the ordinary organized public service in the Los Angeles County area. Although this council was created primarily to combat disruption of service due to

earthquakes, floods and major conflagrations, the very basis of the organization lent itself admirably well to the present war emergency. Very little change in plan was necessary to adapt it to this purpose.

Development of Protection Plan

More than two years ago, the Department of Water and Power created an Anti-Subversive Committee, the name of which was later changed to Plant Protection Committee, charged with the responsibility and authority to determine the relative importance of the various units of the system and to recommend steps to be taken for the adequate protection against acts of sabotage. This committee was composed of five division heads of the department.

Prior to December 7, 1941, a complete survey was made of all water bureau properties and facilities to determine steps necessary to prevent interruptions in service from acts of sabotage. All caretakers and patrolmen were armed and deputized; fencing was installed around important distribution reservoirs; "No Loitering or Trespassing" signs were posted; each employee was photographed and fingerprinted, and a check made with the Federal Bureau of Investigation in Washington; passes were issued to each employee; and, in general, every step possible was taken that did not tend to jeopardize relationships with the public.

Subsequent to December 7, 1941, definite and concise steps could be and were taken to augment the program of preparedness that had already been adopted. Guards were placed at all important gate vaults 24 hours a day, seven days a week, until all covers were fastened securely by means of special cap screws. Guarding was made continuous at all distribution reservoirs and fencing of all critical areas was installed. Gates were locked at all times and signs reading: "Keep Away—Under Armed Guard," and "Turn Off Your Headlights; Turn On Your Dome Light," were posted at appropriate locations. Lights were installed as the location warranted and communication between the guards was improved by the installation of telephones and periodic contacts with the local police. The public was prohibited access to all reservoir areas. Covers to reservoir towers were installed, exercising care to provide sufficient air inlet area. Alarm systems were installed and barriers were placed at all entrances to bridges leading to reservoir towers. Fish were placed in a barrel below each distribution reservoir through which flows a small portion of the outlet water, and periodic inspection by guards on duty to determine any abnormal change in the condition of the reservoir water was ordered.

A volunteer guard force of some 350 men employees has been organized in squads not to exceed 15 men, geographically located as to their residence, who can be called upon at any time to do guard duty in the event of an ex-

treme emergency. These men equip themselves completely and would be required to go to any location without any assistance.

The management of the Bureau of Water Works and Supply has long recognized its obligation to protect its properties against any acts of sabotage which would affect the continuity and quality of service to the consumers. In accordance with this policy, all protective measures as outlined above have been effected. To insure adequacy and to protect the continuity of its water supply, the Bureau of Water Works and Supply, in addition to its primary source of water, the Owens River Aqueduct, has effected connections with the Metropolitan Water District and maintains its wells and pumping plants as standby units that may be pressed into service with less than one hour's notice.

Objectives of Guarding

The proper objectives in guarding water works property should be based on the speed with which service can be re-established after an outrage has occurred and the damage that could result to the war effort from this interrupted service. A complete survey should be made of the water works system with the above facts foremost in mind. In Los Angeles, with a long aqueduct as the principal source of supply, it is necessary to weigh very carefully the in-town and out-of-town storage facilities. If, as was determined, the close-in storage facilities are sufficient to carry through an emergency of two or three months' duration, then skeleton guarding of the aqueduct and out-of-town storage facilities would be adequate. Distribution reservoirs, pumping plants, gate vaults and exposed pipe in the system should be carefully studied and protection afforded each unit that is commensurate with the damage that would be done if an outage occurred. In some instances, it is possible to place a guard at a particular location and equip him so that he could offer considerable resistance to an organized attempt to commit sabotage; but generally the only protection that can be afforded is a good alarm system, i.e., the guard will be able to resist a minor attempt long enough for organized help to arrive. Employees should be organized into gate turn-off crews, divided into squads depending upon the district where they live. At least one competent man should be assigned to each squad. The function of these crews is to isolate areas where mains have been broken in order to maintain the pressure of the surrounding area.

The relationship of the water department to other agencies having a definite interest in preserving continuity of service should be carefully maintained. Additional protection can be obtained by requesting the local police to investigate any individual or group of individuals who are digging in the street or have a manhole open, regardless of whether they are equipped with department trucks or not. Vital defense plants should

be apprised of the importance of maintaining the water facility for their plants at all times.

Co-operative measures sometimes can be effected between various utilities in guarding a concentration of vital facilities in a certain location, but methods of guarding are so difficult that local *law* enforcing agencies should be called in to furnish advice and co-operation.

Allocation of Funds

The amount of money that should be allocated to plant protection activity varies so greatly from one water department to another, and is dependent on so many factors, such as size of the city and number of people served, type of industries served, location of city, etc., that the author hesitates to give any analysis of the program of the Los Angeles Bureau of Water Works and Supply for fear that it may be misinterpreted. Gross revenue for the twelve-month period ending April 30, 1942, was $12,990,000. An item of $860,000 is set up in the budget to cover, for the period of one year, the extraordinary expense in plant protection and repair of damage due to the war emergency. In other words, the Bureau of Water Works and Supply plans to spend approximately 7 per cent of its total gross revenue in plant protection and repair activity.

The primary value of guarding is the actual physical protection of water works property. Any value that may be derived in raising the public morale is incidental. Water works managements have been charged with a definite responsibility by the people and they cannot shirk it. It is true that ordinarily the local law enforcing agencies would be required to perform this duty, *but this is no ordinary situation.* We are at war, and all agencies for law enforcing, as well as utilities, have a job that taxes their personnel to the limit. It is up to each water works to provide as complete a system of guarding and protection as it can with the facilities available. It is believed that, with the exception of conditions such as may prevail under an actual state of siege, open hostilities or other extreme emergency, the department forces will be capable of protecting the water system of the Bureau of Water Works and Supply of the city of Los Angeles.

The Mutual Aid Plan at Work

By Howard H. Potter, Earl Devendorf and John H. Murdoch Jr.

Maine—Howard H. Potter

THE history of the Mutual Aid Plan in Maine dates back to December 1940, when the Dean of the University of Maine wrote to the Chief Engineer of the Portland Water District regarding the fact that the federal government proposed to provide funds for an Engineering Defense Training Program and asking his assistance in establishing such a training course in the city of Portland.

In the state there is an association of water works officials known as the Maine Water Utilities Association, which has a membership of 66 utilities, or 40 per cent of the total number in the state. In point of consumers served, however, it represents 90 per cent. Meetings are held bimonthly and a journal is published to be issued in the months in which meetings are not held. Average attendance is from 120 to 130, representing from 30 to 40 utilities. These figures are mentioned to give an idea of the activity of the association, and to show its rather widespread influence over all—certainly over all the larger—utilities of the state.

When the above mentioned letter was read at the December 1940 meeting of the association, it aroused considerable discussion, so that its president appointed a committee to study the proposition and see if it could be broadened to take in not only engineers and technicians, but all water works employees and fire department personnel. The committee met with the Dean and later prepared a preliminary program of study which was forwarded to Washington for approval.

A symposium presented on June 23, 1942, at the Chicago Conference, by Howard H. Potter, Water Works Engr., Maine Public Utilities Com., Augusta, Me.; Earl Devendorf, State Water Supply Co-ordinator and Asst. Director, Div. of Sanitation, State Dept. of Health, Albany, N.Y.; and John H. Murdoch Jr., Pres., Pennsylvania Water Works Assn. and Gen. Chairman, Pennsylvania Public Water Supply Defense Organization, Harrisburg, Pa. Clarence W. Klassen, Chief San. Engr., State Dept. of Public Health, Springfield, Ill., also participated in this discussion, but his contribution is not yet available for publication.

Approval was given, but, as funds were not to be made available until later in the summer, the association decided to underwrite the school to the amount of $2,000, reimbursement to be made when the money was received from the government. Stephen H. Taylor, for many years Superintendent of Water Works at New Bedford, Mass., was engaged as Executive Secretary of the school.

A prospectus issued in February 1941 said the school would consist of "lectures by outstanding specialists in various lines, and among others will be consulting engineers, college professors, leading water works officials and others who have made special studies and have special knowledge. Much is now known in this country about what has been learned in England and on the continent about what to do under emergency conditions. This information will be made available to those attending the schools in Maine."

The original plan was to have sessions of the school Monday and Tuesday of each week at the University, in Orono, Wednesday and Thursday at Augusta, and Friday and Saturday at Portland. Water works men would attend those sessions nearest their locality. The first night was to be devoted to the lecture by the scheduled speaker, and the second night a discussion and question period. After the school started it was found that there was not really enough discussion to occupy an entire evening, many of the speakers did not take all the allotted time, and a wider distribution of meeting places seemed desirable. Accordingly, lectures and question periods were combined into one evening's program, and five meeting places instead of three were arranged. (A list of the subjects covered and the speakers is given in the Abstracts section of the JOURNAL (Jour. A.W.W.A., **34:** 134 (1942)).

The entire course ran from late March through the entire month of June, and at its completion the entire set of lectures was published by the association and sent to every water superintendent in the state, having a rather wide circulation outside the state as well.

Survey of Materials Needs

During the preparation of his lecture in the course it came to the author's attention that the fire departments of the state were, at least on paper, organized along co-operative lines. For some time it had been the author's opinion that an organization as strong as was the Maine Water Utilities Association could better take the responsibility for preparing for emergency conditions than for each utility to make purchases with an eye to its own needs alone. In his lecture, therefore, the author made this suggestion:

"If our water utilities were to be organized somewhat in the way in which fire departments are organized, with some central directing agency,

a survey could then be made by some capable individual or committee as to probable needs for emergency stocks, and each utility large or small, could be given an idea, at least, as to how best to spend its available funds. Then when the emergency does arise the utility in need of help can call on the central agency, or clearing house, and be directed as to the nearest place where it can obtain the needed parts. Obviously such a plan will help, at least, to prevent much duplication or overstocking in some items, with consequent shortages in others."

On July 8, 1941, Fred J. Reny of the Portland Water District, Acting President of the association, sent out a letter to various members of the association asking for an expression of opinion relative to the "employment of a competent man to work under the direction of a committee to be appointed by the association to survey the stock of repair parts and supplies pertaining principally to supply and transmission mains, distribution mains, chlorination equipment and parts, emergency pumpage and pumps, and other necessary equipment in the water utilities of the state, and also to recommend the procurement of additional equipment and supplies where the committee considers it advisable."

Since the response to the letter was favorable, appointment of a general committee of 22, known as the Central Clearing House Committee for Emergency Supplies, of whom eight were named as the executive committee and one as paid executive secretary, was made at the August meeting. Later, at the December meeting of the association, which followed immediately the declaration of war, it was voted to increase the duties of the committee to include all activities of a defense nature and the committee came to be known as the Defense Committee.

First act of the committee, early in September 1941, was to prepare a questionnaire requesting information on the amounts of material and equipment on hand, together with certain vital statistics. Returns of the questionnaire, which was sent to every public water supply in the state, were noted on cards from which the information was later transferred to a looseleaf notebook. Most of the utilities were very prompt in replying, and after a reasonable period the names of the last few stragglers were submitted to the Public Utilities Commission, which issued an order requiring them to furnish the information forthwith.

When the bulk of the materials questionnaires had been returned, a second questionnaire—on manpower—was prepared and sent out. The information requested was divided into the following several classifications: foremen, air tool operators, joint makers, smelters, pipe cutters, experienced diggers, electricians and portable chlorinator operators. The replies were specifically limited to those men who might be available for service outside their own communities. Also, one man, if proficient, might be listed in several classifications.

Work of State Water Co-ordinator

When toward the end of December the State Water Co-ordinator was appointed, then, most of his early work had already been completed. When he took office, the association, very kindly, and without the least reluctance, made all the information available to him.

The Defense Committee had also divided the state into nine zones, later increased to ten, for each of which a co-ordinator and assistant co-ordinator were appointed. The general inventories of materials and manpower having been completed, they were broken down into the zones, and each zone co-ordinator and his assistant were given copies of their zone inventories. The State Water Co-ordinator has one of the master copies and another is in the possession of the Defense Committee Secretary. The first page of each zone inventory in addition to giving the names, addresses and telephone numbers of the zone co-ordinators, lists the utilities in that zone with the names of the superintendents, the name, address and telephone number of the state district sanitary engineer in that zone, laboratory facilities which may be available, and a list of the portable chlorinators in the zone, including those which are state owned and available through the district sanitary engineer, those owned by utilities in the zone, and those privately owned. Of this latter group there are quite a number, owned by private summer estates and vacation resorts, including a very large number of boys and girls camps. In the event of emergency, it is almost certain that these would be made available voluntarily, but if necessary they could be requisitioned under powers granted to the Governor once he has declared a state of emergency.

Having received information on the amount of materials on hand, the next step was to determine the amount of material needed to provide adequate protection in each zone. This work had also been started and was carried to completion under the direction of the Defense Committee. Certain arbitrary assumptions were made: First was that, to repair any break due to bomb damage, the following amounts of material would be needed: two lengths of pipe, two sleeves, one tee, one gate valve, one plug. Next was that there would be one break for every ten miles of main in the system.

It has already been mentioned that the questionnaire requested each utility to give the number of feet or miles of pipe of each size in its system. From this information, using the above assumptions, the amount of materials necessary for each utility was determined. The difference between this amount and the amount actually on hand was entered on a work sheet —plus or minus, as the case might be. The totals for all utilities in a given zone were then obtained.

In most items the result was a plus figure. Where inventories were short, the cause was generally a deficiency on the part of the smaller utilities, which were, of course, just the ones least able financially to make it up. Requests for additional purchases were therefore made of the utilities better able to bear the expense, and the response was very gratifying. In not more than one, or possibly two, instances was any objection raised. It is therefore possible to say at this time that, so far as can possibly be predicted, every zone has enough materials to cope with what future possible damage might reasonably be expected.

To keep all inventories up to date, a two-column checking inventory sheet has been prepared, covering all items listed in the original inventory. On April 15, 1942, the first check was made. For each utility in his zone, the zone co-ordinator listed in the "Zone" column the amount which that utility showed. These sheets were then sent out to the utilities who were requested to enter in the "Stock" column a check mark if the amount shown was correct, and the correct figure if the original amount had changed. Space was also provided for any additional materials or equipment which had been obtained since the original inventory. Having completed this check the utility then returned the sheet to the zone co-ordinator who made the proper entries in his zone inventory and forwarded the sheet to the State Co-ordinator who, in turn, made the necessary changes in his master inventory. The sheet was then forwarded to the Secretary of the Defense Committee who changed his listing, returning it to the zone co-ordinator for use in making up his next checking sheet.

It is expected that these checks will be made at the beginning of the spring season, and again at the end of the summer. A mid-summer check may be made if it seems warranted when the time comes. With shortages of material, however, it is not expected that the amount of work done during the summer will approach that of normal times, so that the interim check will probably not be made.

Although most state co-ordinators are health department men, in Maine, this is not true. Since every water supply which sells water at established rates is a public utility, whether publicly or privately owned, and comes under the jurisdiction of the Public Utilities Commission, the co-ordinator has been taken from its staff. The commission alone has power to issue orders to utilities. In health matters the Bureau of Health may advise, but, except in times of emergency, it has no authority to require a water utility to do anything. If this seems a peculiar situation, it might be added that the Water Works Engineer of the commission has always worked in close collaboration with the engineers of the Bureau of Health to secure necessary sanitary improvements. In order that the health department might be adequately represented in the organization, however,

the Director of the Bureau of Health was appointed Associate Co-ordinator, and he, in turn, delegated the actual work to the Supervising Sanitary Engineer of the health department, to whom all details of a strictly health or sanitary nature are delegated.

Legislative Authorization

In January 1942, the Governor called a special session of the Legislature which passed an act creating the Maine Civilian Defense Corps. Under this act the Governor then appointed a Director of Civilian Defense, and a Civilian Defense Council, of which the State Water Co-ordinator was made a member. In this way the authority of the State Water Co-ordinator derives from the public laws of the state.

The zone co-ordinators and their assistants are all water utility superintendents, who are also members of the Maine Water Utilities Association, and as such are giving their services unselfishly for the benefit of all the utilities and the general public whom they serve. Through their appointment as zone co-ordinators they also become members of the Civilian Defense Corps and are under the directions of the State Co-ordinator.

In the event of emergency it is planned that any utility in need of help, either in material or manpower, will first call either the zone co-ordinator or his assistant, whichever is nearer. By reference to his inventory the co-ordinator will tell him where the needed help can be obtained and, if necessary, take the necessary steps to see that he gets it. If it is not available in the zone, the zone co-ordinator will call the State Co-ordinator who will inform him of the nearest possible point at which it can be obtained. If, for any reason, the State Co-ordinator cannot be reached, the Secretary of the Defense Committee, also in Augusta, will be able to give the information.

While it has been endeavored to foresee every possible contingency and prepare for it, it is probable that not until the actual emergency comes will all the imperfections in the system become evident. What seems the most probable cause of difficulty is the expected breakdown of communications, and for that it is impossible to prepare until the extent of such breakdown is known.

Boy Scouts have been trained for messenger service. For control center work they can be used to good purpose to replace a telephone which is out of order; but if all telephone service leading out of a town is disrupted that will raise a problem which cannot now be answered. The best information from the telephone company is that to disrupt all ingoing and outgoing service will require a direct hit on the central office and that even in such a case there are some alternative means of maintaining communication. The answers to these and many other questions, however, will remain unanswered until on actual bombing occurs.

The author is not familiar with the mutual aid organizations of other states, but is under the impression that that of Maine is a much more loosely knit affair than usual. It is very evident that the organization is largely that of the Maine Water Utilities Association under the direction of a state official. There is nothing in the law to compel the association to accept the State Co-ordinator's direction, any more than there is anything in the law to compel him to adopt that organization, but it does not take any great degree of perception to see that it would have been a useless duplication of effort to set up a separate organization when there already was such an efficient one in existence. The two authorities have not always seen eye to eye, and there may very possibly be future instances of disagreement, but such disagreements have never obstructed co-operative effort toward the common objective—and with the least possible delay.

New York State—Earl Devendorf

THE Mutual Aid Plan for Water Service in New York State was ordered into operation on October 14, 1941, by Governor Herbert H. Lehman, to be carried on as a part of the civilian defense program in close co-operation with all local water officials and co-ordinated with the work of local defense (now war) councils.

The plan was formulated by a committee of water works experts appointed, at the request of the Governor, by the New York State Conference of Mayors and the New York State Department of Health.* The plan provides for dividing the state into 23 zones with an outstanding water works official in each appointed as zone co-ordinator, the district engineers of the state department of health and the county sanitary engineers of Westchester, Nassau and Suffolk Counties being assistant zone co-ordinators. With the exception of New York City and Westchester, Nassau and Suffolk Counties, which constitute separate zones, the zones correspond to the existing state health department districts.

At the regular session of the 1942 New York State Legislature two bills relating to the Mutual Aid Plan and providing needed authority for carrying out its objectives were passed. One law, constituting Chapter 544, set up a State War Council, with wide, sweeping powers, and established a State Office of Civilian Protection under the jurisdiction of the State War Council. The other law, constituting Chapter 574, provided for carrying out other specific objectives of the Mutual Aid Plan. This

* For a description of the steps preliminary to the formulation of the program, *see* DAPPERT, ANSELMO F. New York State Mutual Aid Plan for Water Service in Case of Emergencies. Jour. A.W.W.A., **34**: 189 (1942).

legislation was enacted several months after the Mutual Aid Plan was placed in operation. Although the legislation was necessary to carry the plan fully into effect, a great deal was accomplished before its passage.

Objectives of the Plan

The objectives of the plan may be outlined briefly as follows:

1. To promote to the fullest possible extent the inter-system connection of municipal water supplies with adjoining public water supply systems and with the approved water supplies of industries or other approved systems, so that, in the event of failure of one supply, continuation of water service may be assured by the other

2. To bring maps of distribution systems completely up to date and to require maintenance of accurate records as to location of valves, hydrants and other vital parts of the distributing systems, so that, in the event of an emergency, no delay will occur as a result of inability quickly to locate essential points

3. To co-operate with local fire authorities in regard to survey of all possible emergency sources of supply in each community and in regard to preparations for their possible use, as well as to supply full information to fire authorities in regard to valve and hydrant characteristics and to make a detailed study of distribution systems with a view to ascertaining and correcting weaknesses and deficiencies

4. To co-operate with local fire officials and defense industries in determining the adequacy of water supply and fire protection furnished to defense industries with a view to ascertaining and correcting deficiencies

5. To co-operate with power companies and other utilities in regard to deficiencies in power supply and determination and application of the measures necessary to continue water service in the event of power failure

6. To co-operate with local war councils and local civil defense directors in integrating plans for the protection and repair of water works with the defense plans of the local community and to train volunteer workers assigned by local offices of civilian mobilization in the technics of water works operation and repairs so that, in the event of an emergency, such volunteer workers will be supervised by regular water department personnel

7. To make studies in regard to the needs of and to take all necessary steps to protect water supplies against possible sabotage

8. To prepare a detailed inventory of water works personnel, equipment and supplies and file this with the zone co-ordinator so that, in the event of an emergency, needed assistance to any community in distress can be arranged for promptly.

In summation, there are two distinct fields of effort: *first*, that of general preparation for emergencies, including all of the objectives of the water service plan that do not have an immediate and direct connection to the civilian protection plans for mobilization and direction of civilian protection services in an actual emergency; *second*, in the field of civilian protection, three objectives relating directly to those things which must be done to integrate local water departments with the civilian protection plan of each community and to secure the organization and training of water main emergency repair crews and other water works auxiliaries who will be urgently needed in the event of an actual emergency.

Plan of Organization

The Governor appointed a State Water Supply Co-ordinator to direct the carrying out of the specific objectives of the Mutual Aid Plan, giving him also the position of Director of the Division of Water Main Emergency Repairs under the State Office of Civilian Protection to act as technical advisor to the State Director of Civilian Protection and as directing head of the plan on all matters relating to the organization, training, equipment and operation of emergency repair crews and other auxiliary or repair water works personnel as well as other matters relating to the integration of the civilian protection features of the Mutual Aid Plan with the plans of local directors of civilian protection. The work of supervision and direction is decentralized throughout the state through the offices of the zone and assistant zone co-ordinators in the respective areas under their supervision.

A manual for the instruction, information and guidance of local health, water, sewer and milk officials, and chairmen of local war councils and directors of civilian protection has been prepared. This manual describes not only the specific plans and preparatory steps which should be taken in advance of any emergency but also the detailed emergency organization which should be developed as a part of the civilian protection services which are necessary efficiently to maintain or to permit restoration of these vital services. The manual also gives technical advice for the guidance of local authorities in meeting special problems involved in the preparation for and handling of serious emergencies and the procedures on which these vital services are integrated with the civilian protection plans of each community.

As a supplement to this manual of emergency sanitation services, there has been prepared a bulletin* designed to serve as a guide to the local

* Organization and Training of Water Main Emergency Repair Crews and Auxiliary Personnel Assigned to Emergency Water Service Duties. *Water Series, Bulletin No. 1.* Jour. A.W.W.A., **34:** 803 (1942).

directors of civilian protection and local water officials in the organization, development and training of auxiliary or volunteer emergency water main repair crews and other auxiliary personnel assigned to emergency water service duty. This bulletin gives a detailed outline of the qualifications required for the volunteer personnel assigned to the emergency water service duty. The extent of such personnel required has been determined. Details of training courses for the proposed repair crews and instruction methods are also outlined in the bulletin, the program having been worked out in co-operation with the Bureau of Public Service Training of the state department of education, now the Division of War Training of the State War Council, and the Municipal Training Institute of the New York State Conference of Mayors and Other Municipal Officials.

Schools are to be held throughout the state during July 1942 for the purpose of training the regular employees of the water department in order to prepare them to train the volunteer emergency civilian repair crews to be organized at the local level.

Accomplishments to Date

In the first eight months of operation of the Mutual Aid Plan in New York State, the accomplishments in the field of general preparation have been enormous. The fact that such good progress has been attained reflects great credit on the interest and assistance of the municipal authorities and the zone and assistant zone co-ordinators. The program has been attended by certain difficulties. Questions have arisen from time to time for which no adequate answers have yet been found. Such confusion and uncertainties as may have existed at the time the program was begun, however, have been materially reduced.

Some of the accomplishments of the program may be summarized briefly as follows:

1. Of a total of 274 proposed inter-system connections, some 200 have been installed.

2. 371 communities have submitted maps of water supply distributing systems.

3. 341 communities have made surveys of possible emergency water supplies.

4. 187 communities have made surveys of their water distribution systems for weaknesses.

5. 49 communities have made special studies of water service and fire protection to defense industries.

6. 25 communities have made special studies in co-operation with power officials.

7. 45 communities have already undertaken the organization and training of auxiliary water works personnel.

8. 162 communities have given special attention to protection against possible water works sabotage.

9. 684 communities have submitted inventories of water works equipment, materials, supplies and personnel.

There is no feature of the program of more importance today to municipal authorities and water works officials in view of the ever-increasing difficulty of obtaining critical materials which may be needed on short notice in case of emergency. The availability of this information in ready reference form makes it possible to arrange promptly for the loan of needed material and equipment. This feature of the Mutual Aid Plan for Water Service is now substantially in complete and effective operation.

Immediate Problems for the Future

So far, activities have centered for the most part around those objectives which have been catalogued as in the field of general preparations. There has been achieved a certain uniformity in activities and methods which is an essential and desirable characteristic feature of any comprehensive plan. Some aspects are far advanced, others, not so far. It all takes time. Work has been done on the principle of decentralization, but according to a rather definite and well formulated plan. The plan is to continue activities toward all of the objectives in the field of general preparation as rapidly as possible. For the next few months at least, however, efforts will have to be concentrated in the direction of integrating the local water departments with the civilian protection services of each community and of securing the organization and training of water main emergency repair crews and other water works auxiliaries who will be urgently needed in event of actual emergency.

Air raid warning services, emergency medical and fire protection services have already been developed. Other essential emergency services are in formulation under the civilian protection program. As yet, with relatively few exceptions, not much progress has been made in setting up the essential emergency water services that will be so urgently needed in the event of an air attack. This phase of the program was discussed early in June at a meeting of the zone and assistant zone co-ordinators in Albany, in which representatives of federal, state and local water authorities participated. At a subsequent meeting later in the month a definite program and schedule of training schools to be held throughout the state was agreed upon as the first step in this program of organizing and training volunteer civilian emergency repair crews.

As has been mentioned, these first schools are for the purpose of training and instructing the key municipal water works personnel in the state in order that they, in turn, may be better prepared to act as instructors to

the large number of volunteer civilian emergency repair crews to be organized by the Director of the Office of Civilian Mobilization.

The program of organizing and training of civilian emergency water supply crews, now just beginning, is without question the largest problem faced. It will require, first, the holding of five three-day schools for the key water works personnel throughout the state. Then, it will be necessary to ascertain that each of the more than 1,200 water systems has emergency civilian auxiliary repair crews organized and trained.

The Division of War Training of the State War Council and the Municipal Training Institute of the New York State Conference of Mayors and Other Municipal Officials have offered the services of their organizations and officers in drawing up the programs and arranging for the holding of these schools. Similarly the Association of Towns and the New York State Section of the American Water Works Association have offered assistance. These offers are greatly appreciated and have been gratefully accepted. In fact, without such assistance it would be impossible to assume the responsibilities required to carry out this training school program.

Another important task is that of ascertaining that the responsible local water official is represented at the Office of the Local Director of Civilian Defense and that a complete and accurate record of the water works systems is available. The water works superintendent must assume the responsibility for making certain that he is so represented and must arrange for prompt attendance at practice blackout trials in order that each responsible official will be available and ready for emergencies.

The importance of having fire department co-operation has been emphasized from the very beginning of the New York State program. It has been pointed out that fire departments have been accustomed to depend upon the availability of public water systems for the required water to fight fires and have ordinarily given little thought to the necessity of emergency supplies. Unless there is complete co-operation and exchange of information between the fire and water departments, so that the fire departments know where the emergency supplies are and how to use them, the water departments have wasted their time in arranging for such emergency supplies.

Local water superintendents and local fire chiefs should be encouraged to consult each other and work out plans for the necessary close co-operation in the location and maintenance of valves and fire hydrants, provision of necessary hose adapters, survey of all possible sources of emergency water supplies and prearranged agreement as to the circumstances of their use, needed reinforcement in grid systems, etc.

It must be remembered that the army authorities hold the water works superintendent in each municipality responsible for an uninterrupted supply of water for the continued operation of defense industries. In the

event of bombing it is certain that public water and sewer systems will be damaged. While it is possible to lay small temporary lines on the surface to give a supply for domestic use, these small lines would hardly be adequate for the industrial uses required by industry. It is essential, therefore, that the public works departments and water departments co-ordinate plans through civilian protection directors for the necessary equipment and personnel for making such repairs.

These and the other objectives of the state-wide Mutual Aid Plan for Water Service have been outlined in the recently issued manual and bulletin which have been sent all water works authorities and the local war councils. The manual was prepared after weeks of collaboration with the State Office of Civilian Protection and not only has the approval of, but appears as an issue of, that office. Accordingly, it becomes a directive not only to the local water authorities, but also to the local war councils and directors of civilian protection. The stage has been set, therefore, for full co-operation between the local fire departments, water authorities, war councils and directors of civilian protection, to promote their efforts in the full development of the objectives of the program.

Value and Importance of the Mutual Aid Plan

Reports from the various zones indicate that deficiencies and weaknesses in various distribution systems have been revealed and corrected. These instances vary in cause from inoperative air valves to valves which have been found closed on supply lines. Unless these deficiencies are discovered and corrected, large fires caused by bombing could not be controlled because of inadequate water supply.

The plan has met with the instantaneous favor of municipal and water officials throughout the state. Many of the water distribution systems have been inter-connected with adjoining municipalities and many other inter-system connections are being planned. The operation of the plan has in addition resulted in co-ordinating the work of the water and fire departments, which is of vital importance in case of any serious damage by enemy action.

In view of the increasing difficulty of obtaining critical materials for water works construction, the Mutual Aid Plan is of inestimable value in that the inventories of available stock permit obtaining needed critical materials by borrowing from adjoining municipalities in case of emergencies. In these times it would otherwise be impossible to obtain the critical materials needed.

While the Mutual Aid Plan is a product of the war, experiences in New York State in the few months that it has been in operation indicate that it will be of value even in peacetime.

Pennsylvania—John H. Murdoch Jr.

THE Mutual Aid Plan in Pennsylvania was brought into existence on the night of December 10, 1941, the third day after Pearl Harbor. It grew out of a meeting held in Harrisburg on that day attended by a group of water works men and representatives of the State Department of Health, the Public Utility Commission, the State Motor Police, the Pennsylvania Reserve Defense Corps and the State Council of Defense.

At that meeting it was emphasized that water service must be maintained under all circumstances, that there was real danger of sabotage and the distinct possibility of enemy bombings and finally that, except for military defense against mass enemy action, it was the problem of water works men to defend themselves and to keep water flowing. It was agreed that action must be taken quickly to acquaint all water works operators with the need for alertness and that co-operation should be assured. Because of that general agreement, but without any authority, the author, as General Chairman of what has been named the Pennsylvania Public Water Supply Defense Organization, went to work immediately, dividing the state into fifteen districts and appointing a district chairman for each. By noon, December 11, organization was completed and operations under way.

Lack of Authorization

One important consideration in the study of mutual aid plans is the authority under which the organization was initiated. In the case of Pennsylvania the explanation is simple, no authority having been given. The first meeting was called on December 10 because the Governor and the Chairman of the Public Utility Commission insisted that something be done, but they did not then and have not since given any authority and none has been requested. The work of setting up the district organization was undertaken because those who attended the first informal meeting believed there was a real danger and wanted something done. The plan "just happened" without knowledge that similar organizations were being formed in other states. The district chairmen accepted their posts knowing that the entire scheme was voluntary and had no foundation in law.

The organization was fortunate in that the Chief Engineer of the State Department of Health, the head of the State Motor Police, the commanding officer of the Pennsylvania Reserve Defense Corps and the Executive Director of the State Council of Defense at once approved the plan and the organization and directed all those serving under them to co-operate.

That co-operation has continued and has been invaluable. Since the U.S. Public Health Service was given the assignment of effecting the development and execution of the Facility Security Program with respect to water supply, under the Office of Civilian Defense, much valuable help has been received from that organization as well. This co-operation and active encouragement from those having authority is the only authority that has ever been given.

Work of Organization

As has been stated, there are fifteen districts in the state with a district chairman in charge of each. The district chairmen then appoint county chairmen, and, in a few instances, they appoint deputy or subdistrict chairmen. A central clearing office is located in Harrisburg. The work of the General Chairman consists merely of keeping the work in motion by maintaining contact with those who are doing the work.

Each district chairman is left to his own initiative to work out his own ideas but he is urged to do six specific things:

1. Acquaint each water supply agency in the district with their duties, as agreed upon at a meeting of the district chairmen
2. Urge the managers of each water system to prepare it to take care of itself with adequate material and trained personnel
3. Get pledges of co-operation and get confidential inventories of the men and materials available at each plant
4. Make up a district inventory from the confidential individual inventories and forward it to the Harrisburg office
5. Make a friendly but critical check on the water utilities to be sure they are giving proper attention to their plants from a war standpoint
6. Stand ready to round up men and materials when needed.

If a call for help comes it is to be directed to the district chairman and he should rely on the resources of his own district first, calling on his neighboring districts or on the Harrisburg office only in case of needs which cannot be met from the resources of his own district. The chairmen are cautioned to avoid, so far as possible, the dangerous stripping of the good samaritans.

The organization has been called upon to bring the water supply agencies into proper acting relations with the local, county and state OCD organizations and to give advice on training and co-operation. The primary objective of the Mutual Aid Plan in Pennsylvania is to combine the resources of the water works of the state to the end that the chances of serious failure of public water supply will be minimized. From a war standpoint it is felt that the first duty is to keep water flowing to defense industries and that if a choice is required, facilities must be used first to

protect the supply to such industries. It is believed that the organization should act to guard against failure of essential supplies from any cause and to lessen the damage if there is a failure. For that reason it is urging unusual care in operation, precautions against trespass, adequate check on the loyalty of employees and careful thought regarding the provision of inexpensive fire cisterns. In case of need, district chairmen may call for help even when there has been no enemy action. It is desired to keep water flowing under all circumstances and co-operation should make this possible.

District chairmen are receiving splendid co-operation. Most of the important plants and a fair percentage of the small ones have turned in their inventories. A very few of the large plants have failed in this, but it is expected that if a real need were to arise these plants would co-operate willingly and quickly. As yet, there has been no real test of the plan in Pennsylvania, so it is only the author's opinion when he states that it will rise to the emergency. The organization's educational work has accomplished much in making individual plants alert to the dangers they will have to face and the work of the district chairmen has resulted in a very marked increase in a spirit of friendship and co-operation among plants.

Again it should be pointed out that the organization is unsupported by specific laws, so that any operator or lawyer can raise questions about the innumerable complications that might conceivably be met if one municipality or company went to the help of another in any emergency. Personally, the author has little patience with the raising of these questions and from his experience believes that the questions are raised very often by those who are hunting for excuses for failure to help. If a real crisis comes it is expected that all will face and endure danger and that none will be small enough to demand insurance against risk in giving help to others.

Administrative Problems of Water Works in Wartime

By H. H. Brown, L. A. Geupel, K. K. King, L. G. Lenhardt and H. S. Morse

Milwaukee—H. H. Brown

OF A total of 430 regular employees of the Milwaukee Water Works, nine men have been granted leaves of absence to enter the military service, three have resigned to accept positions in defense industries and nine have resigned to accept other positions. Of these resulting vacancies, the highest paying position was that of Senior Engineer at $250 per month; so to date no employee in a key position has left the city's service and no serious personnel problem has resulted on this account.

One reason that so few employees have entered military service is that the average age of 105 employees at the two major pumping stations is slightly over 50 years. These stations have been in service for a number of years, and with well established operating personnel the resulting average age is well above the draft age. As a result, only one employee, or 0.95 per cent, has entered military service from this division of the Water Department.

The conditions at the Water Purification Plant are somewhat different because this plant is a relatively new structure with younger men making up the operating force of 45 employees. At this plant the average age is 36 years and twelve men, or 26.7 per cent of the total number employed, have been lost. Three employees entered the military service, three accepted positions in defense industries and the other six resigned to accept other positions.

In securing replacements to fill vacancies, no special difficulty has been experienced to date. It seems that permanency of position is the major consideration expressed by applicants for positions, their experience during

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A symposium presented on June 22, 1942, at the Chicago Conference by H. H. Brown, Supt. of Water Works, Milwaukee, Wis.; L. A. Geupel, Supt., Water Works Dept., Evansville, Ind.; K. K. King, Director, Water Dept., Kansas City, Mo.; L. G. Lenhardt, Gen. Mgr., Dept. of Water Supply, Detroit, Mich.; and H. S. Morse, Vice-Pres. & Mgr., Indianapolis Water Co., Indianapolis Ind.

the last depression still being remembered. Applicants are also influenced by the pension system and sick-leave benefits enjoyed by all city employees.

On October 7, 1940, the Common Council passed an ordinance granting employees entering military service the right to return to their position after the emergency. Not only is the position vacated by an employee entering the military service promised to that employee upon his return, but any resulting promotions are treated similarly. As a result, accurate and complete records must be kept in order to be able to unscramble, at some future time, the many complications that are bound to arise involving civil service rights, seniority, salary questions, etc.

Replacements have not always been made promptly because of the necessity of complying with a local Common Council resolution which requires the approval of the Board of Estimate to fill any vacancy. This is especially disturbing since this board will not give approval for more than one position at a time, even though succeeding vacancies occur due to promotion. Separate approval must be secured as each vacancy occurs, and since the board meets bi-weekly there is often quite a delay in making all appointments.

While employees of the Water Department do not enjoy particularly high salaries and have been generally dissatisfied with present salaries during a period of rising costs, no special salary problems have been raised. In a municipal form of government, salary ordinances are not generally as flexible as the salary scale in private industry and cannot be changed during the year once the annual budget is adopted. In 1942 no general salary raise was awarded, but all laborers were given a flat $10 per month increase and all other employees receiving less than $200 per month were given a flat $5 per month increase.

While the administrative problems of personnel in Milwaukee have not been particularly perplexing to date, an increasingly difficult situation is anticipated. More men will enter military service as the war machine is built up, and the present civil service lists will be exhausted. Greater delays will result in securing replacements; women will have to be used in certain positions instead of men; and the relatively low starting salaries for new employees will make it more difficult to secure applicants.

Service Extension Problems

The major administrative problem in Milwaukee pertaining to the extension of service to defense industries involves a legal issue and decisions rendered by various governing bodies and the courts over a period of years.

The city has had protracted litigation over water service to individuals, corporations and communities outside the city limits during the past fifteen years. Decisions have been rendered to the effect that where the Milwaukee water works utility has voluntarily extended its service to a

suburb or township beyond the corporate city limits, the water utility must take on and serve all applicants for water in that entire suburb or township. Realizing the effects on the owners of the utility, i.e., the citizens of Milwaukee, if an indiscriminate expansion to outsiders were permitted to continue, the Common Council adopted the policy of refusing voluntary extension of water service beyond corporate limits.

Now, with the large expansion of defense industries by the government, these new industries are being located outside the city's boundaries, due to inability to find available sites within the city. If water service to a new defense plant just outside the city is refused, the Water Department is accused of failing to aid the war effort and of being unpatriotic. If water service is permitted, it may jeopardize the department's legal status in future litigation, contrary to the best interests of the utility.

As a solution to this condition, the government agency owning the particular property has been requested to annex that property to the city. In one case, the owners of such property have filed an annexation petition, and the city has co-operated by permitting a water connection even though the annexation proceeding has not been consummated. In another case, the governmental agency owning the property has refused to become annexed and the War Department has ordered the city to serve water subject to later determination of the annexation issue. This action relieved the utility of voluntarily extending its service beyond the city limits and still permitted the war plant to secure water.

Another problem in connection with demands for extending service to the increasing number of war plants in Milwaukee involves the question of the ability of the water utility ultimately to supply a sufficient quantity of water with present facilities. It has been found that different branches of the government, through their respective agencies, are in charge of and building these plants. Each agency is acting independently and appears interested only in water service to its particular project without consideration of the water needs of other projects. This lack of co-operation and co-ordination as to the ability or capacity of the water utility as a whole to meet the demands of the government for water service in this area may ultimately lead to a serious restriction of the war effort. The condition has been called to the attention of one of the co-ordinating officers with the request that a survey be made by the proper department of the government, analyzing the water demands of all war plants and proposed plants in this area.

There are many other problems regarding demands for extension of service that involve materials, priorities, etc., but since such problems are without the scope of this discussion the author will conclude with the observation that it certainly should be a relatively easy task to handle administrative problems of a water works after this war is over.

Evansville, Ind.—L. A. Geupel

WHEN, as part of the nation-wide preparations for wartime emergencies, water works men were asked to teach their employees valve location and control as well as how to lay and calk pipe, fittings, hydrants and valves in the distribution system, the response was more than satisfactory. In Evansville, as its contribution to the all-out war effort, the Water Works Department proceeded to train sixteen men in these tasks, placing them in the increased straight-pay group. As wartime activities increased, however, the personnel demands of defense plants and Army camp construction contractors attracted many of these trained men away from their jobs in the water department.

In one week the Evansville Water Works Department lost fourteen $30-per-week men to such other employers who were willing to pay an average of between $115 and $125 a week. In such a situation there is little that a water works superintendent can do. He is glad to see his men earn more money, but he knows that if he trains more men in the same jobs, they, too, will sooner or later be lost in the same way.

It is easy to say that the men would remain if they were paid comparable wages, but no water works in the average city of 100,000–200,000 in the Middle West can afford to pay $1.62½ per hour for pipe men and calkers. The only reply that a superintendent can give to civilian defense officials, who demand proof of his preparation for an emergency, is that the men whom he has trained still live in their homes and will, perhaps, be willing to help in an emergency. The possibility of commandeering such men should also be borne in mind against a serious emergency.

On the whole, little more than this can be done. Key men should be paid well to hold them; diggers, ditch men and the like should be paid their normal wages. Beyond that, the superintendent can only wait and trust that when the emergency comes, some solution to the particular problems which arise will offer itself.

Extension of services to new war plants and housing developments raises another series of problems. Generally such extensions are located beyond the limits of the distribution system and require such additions as 3,000 to 5,000 gpm. non-productive fire protection layouts. Water departments are requested to establish new services that cannot be laid unless the plant or development requesting them is able to extend its own preference ratings to the water works construction.

Water works men are all for all-out war and expect more and more drastic limitations, but to co-operate in the war effort, they too must have co-

operation, particularly in the adjustment of their ability to obtain critical materials to the demands made upon them for additional construction. Although most departments are perfectly willing to experiment with and use substitute materials, it is felt, too, that the necessity for their doing so should be no more pressing than for other users.

Regarding the effect of automobile and tire restrictions upon service activities, the Evansville Water Works Department, by strict observation of daily working procedure, by the laying up of extra trucks and by obtaining the interest of the operators of the mobile equipment, has been able to make substantial savings. In addition, with the co-operation of its personnel, the department has been able to lower gasoline consumption about 20 per cent, or 400 gal. per month.

Kansas City, Mo.—K. K. King

THE personnel problem is one of the most troublesome of the administrative problems of water works in wartime. It is the personnel difficulties encountered in the Water Department at Kansas City, Mo., that the author proposes to discuss in this paper. Personnel problems elsewhere, are no doubt similar, existing in greater or lesser degree, depending upon such factors as type of community, volume of war industry, extent of political influence, effect of trade unions, comparative salary scales, available funds, etc.

In April 1940 the citizens of Kansas City elected a Mayor and Council composed of highly respected and capable men, on the platform of restoring to the city a government in accordance with the City Charter. These elected officials at once appointed an experienced and outstanding city manager, and co-operated with him to conduct Kansas City's affairs on a business basis. As a result, really astounding improvements and economies have been obtained and the citizens expressed their approval this spring by re-electing the officials by overwhelming majorities.

Throughout the fiscal year beginning in April 1938, there were nearly 900 employees paid by the Water Department. The following year the situation improved, the number being about 630. Major organization changes in the Water Department were begun in 1940 by the new administration, with great reductions and changes in personnel under conditions where qualified applicants for positions were plentiful. Before the end of the year the number of employees in the Department was reduced to 450 and more and better work was being done.

Conditions of employment, from the viewpoint of the municipal or normal industry employer, are steadily growing worse, and cannot fail to become much more critical rather than better. The salaries and wages being paid in war works, both on construction and in production operations, are beyond competition by the municipality as a whole without increase in tax rates or extreme reductions in services rendered. Certainly local taxes will not be raised before absolutely necessary, since tax authorities are very close to their constituents and know the sentiment of the public. Any additional local taxes are likely to be strongly opposed by taxpayers since necessary increases in federal taxes for war costs and increases in commodity prices impose such a heavy burden, and incomes of so many have not increased proportionately or have decreased due to disruption of normal occupations and businesses.

Well qualified personnel in many classifications already is nearly impossible to employ and retain at the salaries which the Water Department is able to pay. Engineers, draftsmen and other professional and skilled employees are not available, so that less trained and less competent personnel must be engaged and trained as well as possible for the duties that must be performed. When the trainees achieve some degree of skill, they too are likely to be lost, with their predecessors, to war construction and production works, sometimes at salaries nearly double the scale of the city.

Many replacements in office positions have been made with girls, to permit men to go to the armed services, and because it is probably true, whether or not just, that the general wage scale of women is lower than that of men, but this is not now of much help in regard to war industry demands. The department was recently surprised to learn that it will lose one girl to the Army, due to the formation of the Women's Auxiliary Army Corps. It happens that she is a skilled bookkeeping machine operator, difficult to replace, several months, at least, of training or experience being necessary.

During the past fiscal year, from May 1, 1941, to April 30, 1942, the average number of employees in the department was about 450. In this period there were 319 separations, with about the same number of appointments, making the turnover approximately 70 per cent. The annual turnover in the principal office divisions was about 85 per cent, in engineering and operations, about 55 per cent, and in the guards, in only four months, 87 per cent. Part of the reason for the large turnover was the competence of well selected employees, who proved capable of better paying positions in war works. If the department had greater numbers and less competent personnel, the turnover certainly would not have been so great.

Only the small number of ten men went to the armed forces, but it is

certain that this number will be greatly exceeded in the current year. The great majority went to defense or war plant construction or industry, to better their income.

Salary Adjustments

With some exceptions, salaries in city service in Kansas City are quite low for really competent personnel not dependent upon political favoritism. Since the 70 per cent turnover must be admitted to be expensive, applying as it does in the greater part to professional, sub-professional, skilled and semi-skilled services, under proper management salaries for competent employees should be increased to a reasonable degree and in a balanced manner, to lessen the cost of training an excessive number of persons and of carrying extra employees to meet situations arising from sudden desertions. Elimination of an excessive turnover would compensate for many salary increases.

In addition to a need for higher salaries to meet, at least partially, the competition of agencies having apparently unlimited funds, the Water Department has the abnormal expense of providing guards for those parts of the water works system that are most vulnerable or difficult of replacement. The present expense for guards in Kansas City is about 8 per cent of the operating cost, and about 12 per cent of the employees are in the guard service.

During the year, salaries were increased in the department an average of only about 8 per cent. One large problem, however, is that, though the Water Department may still be able to increase salaries, due to efficient operation and sufficient revenues from the sale of water, the master control is under the general city administration which has a compensation plan embracing all departments together; and all departments other than water are supported by tax revenues which are not sufficient to increase salaries as a whole without greater curtailment of services than has as yet been deemed feasible.

To clarify the position of the Water Department in relation to the problem just described, it may be interesting to note that the department has for the past two years had annual operating expenses more than 10 per cent lower than in any year since 1917, and at the same time has had revenues more than 75 per cent above those of 1917. Operating expenses in the past year have been 37 per cent less than those of the fiscal year ending April 30, 1939.

A strong force in the retention of employees is the opportunity given for advancement and promotion within the service, with dependable employment having a future not dependent on war work. Some have established

homes and do not wish to move, and transportation to and from war projects is often difficult, expensive and time consuming. Many employees have a sense of duty and loyalty to the community and to the department to maintain the water service, and they believe they are being treated as fairly as possible under existing conditions.

Some war industries, through governmental action or contracts with employees, have "frozen" employees in positions, to prevent "pirating" by other agencies with ample funds and need of the same kinds of personnel. This cannot be done in water works, at least not unless salaries are increased until they are comparable to those in war industries. Such practices, however, serve only to ruin employee morale and gain no one anything, since it might fairly be considered an injustice.

The personnel problem is always strong, but is now more difficult than normally. The best efforts of water works men will have to be spent in curtailing all services not absolutely essential, both as a matter of patriotic duty and of necessity in order to have funds to increase salaries where suitable and to pay higher materials costs. It will be necessary to try to increase the efficiency of the employees retained and to encourage their spirit of loyalty to their work and to their country. Those in the water works service are exceptionally essential to the health and production of the country in its great war effort.

Detroit—L. G. Lenhardt

IN THE Detroit area the rearmament program started in the latter part of 1940 with the construction of a large number of plants for the manufacture of equipment of war. Since that time more plants have been built, others are building, enlargements of existing plants have been undertaken and the automobile industry has been converted into war production. Generally, new plants have been located without regard to availability of utilities or housing, as it was expected that utilities could be provided and workers transported to the plants by bus or by their own cars, which is the usual means of transportation in the area.

The expansion of industry naturally means that additional workers must be provided. Estimates as to the additional numbers that will be needed by the time production gets into full swing in 1943 vary from 75,000 to 300,000 in migrant workers, 150,000 to 175,000 being the most common. The smallest increase in population on the basis of these estimates is 200,000 within one year and generally it is thought that the population increase will be close to 500,000.

Not only will the industrial expansion require large quantities of water, but the increase in population in itself is that of a city of considerable size. Most of the development is within the area served by the Detroit Department of Water Supply. While one of the industries, the Willow Run Bomber Plant, is planning the use of water from wells for its plant supply, this about uses up such outside sources of supply as are available and hence the district must generally rely on the Detroit supply.

This prospective increased load comes on top of the biggest year's pumpage the department has ever experienced. In 1941, some 102,098,680,000 gallons of water were delivered to the mains, some 7 per cent over the previous high established in 1936 and about 8.5 per cent above the 1940 pumpage. An analysis of the pumpage records shows that this increase was largely due to increased industrial use. Although there was an increased domestic use due to an increase of about 100,000 in connected population, the domestic use per capita declined somewhat. This was probably due to low pressures in the outlying districts where the big bulk of the new residential developments occurred.

New Housing Projects

The first plans for taking care of the housing of the large increase in population were to utilize private construction insofar as possible, together with some large public housing projects which were under construction by the Detroit Housing Commission. In February it was realized that the rubber shortage would necessitate construction of public housing near the workers' place of employment. This was particularly important for the Willow Run Bomber Plant, which is about eighteen miles beyond the Detroit city limits. Accordingly, plans have been projected for the construction of two large public housing projects, primarily to serve workers at Willow Run and other plants in the westerly portion of Wayne County. One of these projects is to be located in the Village of Wayne and will house some 40,000 people, as contrasted with a former population of 5,000. The other is projected adjacent to the Willow Run Plant and will have accommodations for about 100,000 people. The closest city to this latter development is Ypsilanti, with a prewar population of 12,000. Public housing is now planned to be of the dormitory type with the expectation that this will be removed after the war.

Meanwhile, private housing has gone forward. While there is some slackening of private housing due to priorities, probably about 8,000 dwelling units were built in this area during the first six months of the year, as compared with the almost 20,000 last year. Vacancies have been at an all-time low for several months and it is apparent that there will be a

dearth of housing, both public and private, if the higher estimates of additional workers required comes true. Surveys have shown that there still are some 300,000 lots with both water and sewers available in this district. This does not mean that the trunk sewers or transmission mains are adequate or even available in some cases, but it does mean there is a large amount of real estate which is available with a minimum of development.

Service Extensions Within Detroit

As has been indicated, the rapid industrial and residential expansion has not proceeded without difficulties to the water department. Within the city limits some $750,000 has been spent to provide water lines to new or enlarged industries. These commitments were made and largely expended before any governmental agency was set up to assist in financing such extensions. One of these lines involved making available 17 mgd. peak load capacity in an area most difficult to serve. Practically all of this construction had to be rushed to keep pace with a very rapid rate of construction. Most of the lines involved close checking of possible demands as, because of new work or processing, industries did not have a background on which to gage demands. For instance, in one large plant the architect thought 50,000 gpd. would be sufficient, but the department thought plans should provide for at least 2 mgd. Actually over 2 mgd. is being used and this plant is having its capacity tripled. In another case the department was allowed a month in which to supply 1.5 mgd. This extension was ready for service three days ahead of time and the first day's use was over 2 mgd.

The financing of these extensions was made at the sacrifice of some badly needed transmission mains to residential districts. Plans had been made and appropriations were available for this expansion program. It was felt, however, that the urgency of the rearmament program made it necessary to divert appropriations. The Defense Public Works program, which became available about the middle of 1941, was, therefore, welcomed. A project application designed to replace the program from which the appropriation had been diverted was then filed. This project, which was formally filed on September 15, 1941, was finally approved by the F.W.A. on March 23, 1942, in the amount of $1,296,942. The work involved consists of some 55,758 ft. of main of sizes from 12 to 72 in. The larger sizes will be reinforced concrete steel cylinder pipe. The necessary priorities were approved in the middle of June and the work is now [June 22] under advertisement. This will largely remedy the transmission main difficulties within city limits when the project is finally completed. Until the work is completed, however, it is planned to restrict such water use as lawn sprinkling, air-conditioning and the like.

Extensions Beyond City Limits

Although the growth of industry and population within the city has been great, the growth in the area served beyond city limits has been much greater. Huge plants have been built in districts without any form of municipal government other than the township. Tremendous housing developments have taken place with only a township government with all its limitations to cope with the problems. Plants have deliberately been located just over municipal boundary lines so as to escape municipal taxation. The Detroit Department of Water Supply has the express statutory limitation that its funds cannot be expended to supply water beyond city limits.

In one township there was a population growth of from 3,000 to 9,000 within two years. For most of this population neither public water supply nor sewers were available. Shallow wells of some 6 to 8 ft. deep serve as a source of water to most of the people. Sewage is disposed of in the same thin sand seam from which water is obtained. A school of some 300 to 400 pupils gets drinking water from a tank truck. Toilet facilities are indescribable. The limited public water supply to this township comes from the Detroit system through distribution systems of adjacent communities, with the result that pressures are such that there is only a trickle available on the first floor during summer months.

In another down-river township which has a large naval air training base, the situation is similar, although the township has built reservoirs and installed a pumping station. Despite this, there is little or no daytime flow available from the Detroit system during summer months.

The Village of Wayne, some nine miles west of Detroit, had a pre-war population of about 5,000. The war industries in Wayne now have over 6,500 employees and the population of the village has greatly increased. Further, the Federal Public Housing Authority is now planning a housing development of some 40,000 there. This village was served by a 12-in. line from the Detroit system. During the past year, despite the use of an old reservoir, boosting pumps and other expedients, the supply proved entirely inadequate. The village filed a project with the Defense Public Works last year for a 24-in. extension to the Detroit system, but this has been submerged in another application as will be described later.

The cities of Wyandotte and Trenton, lying down-river from Detroit, have both experienced heavy growths. Both cities have requested connections to the Detroit system which the Department of Water Supply has been unable to grant because of lack of transmission mains.

The foregoing cases all refer to conditions west of Detroit and are in that district between the westerly city limits and the westerly line of Wayne

County, and extending northly from the Detroit River roughly to the line of Michigan Avenue (U.S.112) on which the Willow Run Bomber Plant is situated.

In the northeast section, the Chrysler Tank Arsenal and the Hudson Naval Arsenal were both situated in Warren Township, which is in Macomb County. There is only one public housing project in this township, although Detroit is building one close by. From what was chiefly a farming district, with some smaller industries, the township has grown in two years to an estimated 40,000 people. The federal government has recognized its obligations in this district and by loan and grant the financing of water and sewers has been provided. Construction of water lines has just begun. In the interim the few fire hydrants have been used as a source of water supply and sewage has been carried away in ditches. The distribution system will be either directly connected with the Detroit system or served through a transmission main from the Detroit system to the tank arsenal which was financed jointly by the township and the federal government.

Government-Financed Extension Projects

To cope with the situation to the west of the city, where the largest industrial and residential developments are under way and where there is even now a crying need for adequate water supply, there have been filed with the federal government four projects totaling some $7,563,400.

The first of these projects consists of some 83,850 ft. of main of sizes from 16 to 36 in. in diameter. This provides for the basic feeder mains in the so-called down-river area and to the Naval Training Base. Connections to both the Wyandotte and Trenton systems are provided and existing distribution systems up to four miles north of the river will be fed from these mains. This project has just been approved and an A-1-c priority granted. The larger sizes will be constructed of reinforced concrete steel cylinder pipe and bids are now being taken on the material. It is hoped to have this work substantially completed by the end of the year.

The second of the projects involves 55,500 ft. of 54- and 48-in. reinforced concrete steel cylinder water main and is to extend from a connection with a 66-in. feeder main leading from the Springwells Station to about the center of the Village of Wayne. This will provide for feeder mains to Wayne and the intervening territory as well as supplying the proposed housing project in Wayne. The flow to the south will connect with that of the lines mentioned in the first project. This line is also designed to be large enough for a further extension to the west to supply government housing at Willow Run. The estimated cost of this work is $2,425,000. This project has been approved by the F.W.A., but preference rating has

not as yet been issued by W.P.B. Action by the W.P.B. is delayed pending definite commitments on the housing projects.

The third project is an extension of the line out Michigan Avenue from the center of Wayne to the Willow Run housing project. The Ford Motor Co. has requested that, if this line is built, a standby be provided at the bomber plant. This project will cost some $2,298,400 and consists of 50,160 ft. of steel-shell reinforced concrete pressure pipe and cast-iron mains. A booster station is also provided, as there is about a 52-ft. difference in elevation between Wayne and Willow Run. Naturally this project hinges on the final disposition of Willow Run housing.

The fourth project consists of the enlargement of the Springwells Station. This consists largely of completion of the station which was not finished due to the onset of the depression. A reservoir, a pump, a boiler, power lines and completion of filter beds at an estimated cost of $1,340,000, is projected. This will increase the capacity of the station by 80 per cent or 100 mgd. The original cost of the station was almost $30,000,000. In other words, for slightly over 4 per cent of the original cost the capacity can be increased 80 per cent.

Recapitulating, to the Detroit Department of Water Supply has fallen the task of providing for, in the metropolitan area, a prospective population increase of some 500,000 within the next twelve months as well as being the primary source of supply of most industrial plants in the metropolitan area. It also has the task of providing for a past increase in population and a shifting of population within city limits. A program to take care of these wartime conditions has been proposed and the necessary projects submitted to the appropriate governmental agencies. Approval of funds and release of appropriate priorities are being awaited. Time is becoming desperately short, but given speedy action the deadline can still be met. The next twelve months, however, promise to be most hectic.

Indianapolis—H. S. Morse

THE administrative problems of the Indianapolis Water Co. in this emergency may be designated as the three *p*'s—personnel, priorities and pipe lines. Other water works throughout the country are, no doubt, concerned with these same difficulties.

The principal cause of personnel turnover has been the competition of defense industries. Thus far the Indianapolis Water Co. has lost only 20 men to the military services, but many more than that have left for

apparently better jobs. It is interesting to note, however, that recently two men have returned after trying the other jobs.

So far as practicable, employees have been placed on a monthly salary basis, on a 40-hour week, with two weeks vacation with pay, sick leave with pay, absence on account of injury on the job with full pay, group insurance and pensions. The salary schedule has been carefully developed, with job specifications, job analyses, job rating and salary surveys. No flat percentage increases in pay have been made, but increases have been generous and, generally, have exceeded increases in living costs. In spite of this background, the high hourly rated defense jobs at long hours, time and a half and double time for overtime, have attracted many men from their jobs. With further heavy drafts on personnel, the company may be forced to increase the length of the working day with a corresponding increase in rates of pay.

Women are being substituted for men wherever practicable. Some customer services are being reduced and, in meter reading, quarterly rather than monthly readings for domestic customers are being considered, with the thought of estimating consumption on the first and second months.

So far as selective service is concerned it is hoped and expected that the efforts of the A.W.W.A. will bear fruit and that the water works business will be classified and recognized as a defense industry, which, of course, it is.

As to priorities, there is little to be said. The company has no complaint to offer. The War Production Board has a tremendous job which must be done and it is up to water works men to assist in every way possible. When England went into the war, the Indianapolis Water Co. began to put its plant in order so that now it is in good shape for the duration, i.e., for about five years. Difficulty in obtaining replacements can be expected. A let-down in quality or the use of substitutes in some materials will have to be made, but the chief job is to learn how to adjust to these changing conditions without waste of energy and time in fussing and fretting over situations which cannot be avoided.

Pipe lines or water main extensions present a constantly changing problem. In Indianapolis, new defense industries, generally, have been located on the outskirts of the city with little or no regard to the availability of utility services. Thus far, the company has had to spend over $300,000 for special water main extensions to meet these conditions. More recently attention has been paid to availability of water supply and it now looks as if the building of war plants has passed the peak. If this is so, there should be no further difficulty on that score.

New Residential Construction

Residential construction also has passed through various stages. With the new defense plants, population increase put a heavy load on the building industry. In Indianapolis, private capital and builders met the challenge and the F.H.A. has been very co-operative in helping solve this problem in a sane and constructive manner.

In January 1942, a check of company records disclosed that there were over 15,000 vacant lots adjacent to water mains and other utility services, including water service lines to the property line. A card file listing these lots was made and turned over to the local real estate board. Ordinarily, the builders wished a string of lots for economical construction and, as might be expected, lot owners in many cases held out for unreasonable prices; but lots were purchased and homes built until the ceiling in the cost of houses, priorities, and the threat of federal housing slowed down the private builders. Since the first of the year, 78 per cent of building construction has been on lots already adjacent to water mains, and about half of these are on existing service lines. Today private building is almost at a standstill and federal housing is coming in with at least three projects. In selecting sites for these projects, attention has been given to availability of utility services, although of course some water mains must be laid. To date the company has been able to secure the cast-iron pipe, hydrants and valves needed for the critical extensions.

Residential construction beyond city limits and beyond water and sewer lines has presented a difficult problem for health authorities, but tire and auto restrictions and threatened gasoline rationing are slowing down such building.

Since it is privately owned, the Indianapolis Water Co. is very much aware of the rising costs of doing business, especially in respect to taxes. With gross annual operating revenues of slightly over three million dollars, total taxes have now reached $915,000. What the future holds in store is anybody's guess, but it should be pointed out that the company is still operating under a schedule of rates established January 1, 1933.

Wartime Customer Relations

In customer relations a utility starts under the handicap that it is virtually a monopoly and under the customer assumption that dealings must be on a "take-it or leave-it" basis. Keenly aware of this, the company has always made an effort to meet the customer more than half-way. Recently there has been a tendency toward paying less attention to customer rela-

tions in other types of business. In retail stores, for example, with more buyers and less to sell, the "take-it or leave-it" attitude seems to be becoming evident. Also, even in public officials, a careless or dictatorial attitude in customer relations is making itself felt. The tax spender seems to have less regard for the taxpayer than formerly—the *"OR ELSE"* attitude.

Now is the time and opportunity for those in the water works business to give extra attention to customer relations, and this applies as well to water works manufacturers. In this regard it has been pleasing to note, in several instances, that the manufacturers' sales representatives do sense the situation. When they have been unable to render the usual services, they have not "let it go at that" but have been keeping contact with the purchasing agent, helping him in every way they can, or, if they cannot help, telling him why that is so.

Politics

In beginning these remarks the writer listed water works problems as the three *p*'s. A fourth *p*—politics—might be added. Fortunately, the Indianapolis Water Co. is privately owned and blessed with the absence of internal politics, but, of necessity, it has its contacts with various governmental units in which the "politics as usual" atmosphere still prevails. The writer does not know that there is any increase of political maneuvering, but less political maneuvering, locally and nationally, would be in keeping with the times. The lessons to be learned from the fall of France should be taken more to heart. It seems that most Americans have largely failed to do this. It should be stressed that we *are* in a world war and that business, including the water works industry, is fully cognizant of that fact and wants to do its full part. It seems not to be asking too much to expect everyone to act likewise.

The recommendations of this discussion perhaps seem too simple. They are simple—not easy, but simple. There is a job to do that must be done. It appears to the writer that all that water works men must do is to do their part.

Emergency Repair of Distribution Systems

By W. Victor Weir

IF EMERGENCY distribution system repairs are to be handled in the least possible length of time, there must be careful preliminary planning. Everyone involved must be instructed and trained, and proper equipment must be provided. In spite of the fact that distribution system repairs are in most instances handled with dispatch, there is probably room for some improvement in every organization. The wartime requirements that water supply be uninterrupted to war production plants and the wartime hazard that emergency repairs in amounts heretofore unthinkable may be required indicate the need for a review of past and current practices. Thought must be directed not only along the lines of what has happened in the past and what has been done as a result, but what *might* happen and what new methods and equipment are available for use in such emergencies.

This paper may well be divided into the same steps as are followed when emergency repairs of a water works distribution system are required. First, someone is notified that repairs are needed. Second, men are dispatched to the scene. Third, they determine what needs to be done. Fourth, they do it.

The first phase is the notification that an emergency exists. A message must be transmitted to a proper party in the water department. Where night telephone service is maintained, the problem of notifying the proper party, by relaying the message, is readily handled. This night service may be obtained by having a watchman answer phone calls. It may be handled by routing all calls to some station where men are on 24-hour duty. Again, it may be found advantageous to have certain jobs performed at night, such as auto maintenance work, so that one or more men will be available to the telephone at all hours.

The second phase requires the dispatching of men to the scene of the incident. When the description of the damage suffered is full and lucid, a

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proper-sized crew can be dispatched. If, however, the description is meager, or is simply that "our water is off," it may be necessary to send one or more men to reconnoiter the situation.

When an intelligent report comes in, a proper crew and equipment can be dispatched. In several actual instances, where considerable areas were out of service, the intelligent report has come through after long delay, simply because the telephone lines were overloaded with futile but well-meaning messages that there was no water service. To prevent such a breakdown of telephone communications, many utilities have installed unlisted telephones in their service departments, the numbers being known only to foremen and other key men. These men are thus able to obtain telephone communication when the regular lines are swamped with calls which make them practically useless.

In the larger cities, regular night crews are often available on duty to handle off-hours emergency work. These men may play pinochle four nights out of five, or they may perform some duties, such as repair work, which can be dropped immediately upon receipt of an emergency call. One large city water department uses its night crew to perform construction work, to be dropped in the event of an emergency. This crew is contacted by police radio when it is needed.

For most cities, the employment of a night crew is out of the question. The off-hours emergency work must be performed by men called away from their homes. In these cases, men must have telephones and night gangs should be staffed with men living near each other, so they can quickly be picked up.

In the event of occurrence of multiple emergencies, it may be necessary to call out several crews at once. The calling of many men can best be done by the "chain" method. Only one man from a crew is called, and he, in turn, calls the rest of his crew; or two key men are called, and they each call two or three other men. Preparation for multiple emergencies requires the designation of crew personnel ahead of time. Each man must know with whom he is to work and where he is to report. These schedules must be worked out in advance and each man should carry written instructions regarding his individual duty. Properly organized, a few telephone calls should set into motion a whole train of scheduled activity, enabling manpower mobilization in the shortest possible time.

After men have been dispatched to the scene, the third phase is entered—What is to be done? Great volumes of water may be gushing up through the pavement. Valves must be closed. Which valves? And where are they? In these times, it is no longer excusable to have the valve locations in the photographic mind of a man who is sick at home. Neither is it excusable to have a good set of records at the office or on the single emergency truck now required to be several places at one time. The ideal

situation provides each key man and each foreman with a distribution system layout and a complete set of valve records.

These records for use in the field must be complete, simple, not bulky, and easily provided, in as many copies as may be necessary. For small systems, several methods of preparing distribution system records are acceptable. For large systems, the plat and list method, as used in Los Angeles and as outlined in the A.W.W.A. Recommended Practice for Distribution System Records (Jour. A.W.W.A., **32:** 181 (1940)) is extremely satisfactory and flexible. Too much stress cannot be laid upon the necessity for adequate field records. The time available for their preparation is all too short, but their importance requires adequate preparation of this vital assistance during emergencies.

The fourth phase of the problem of emergency repair is simple—the men do it. The proper valves are closed. The excavation is made and de-watered. The pipe is repaired. Service is resumed. All this takes time, and the time involved depends upon the ability of the crew members, their training, their tools and the repair materials used. The job may take as many hours as the inch-diameter of the main if the piece to be replaced is a fitting. Half that time may be average if it is a broken pipe and a permanent repair with a solid sleeve is made. The time may again be cut in half if the repair is made with mechanical joint repair materials.

Equipment to Speed Repairs

Speedy repair is important. No water is available in the affected area for industrial, sanitary or fire fighting purposes. Proper organization and proper equipment are required if the water works man is not to do "too little, too late."

All too often the record shows that it took some other water department from four to six hours to close off a ruptured main. The right valves were not closed at first; or an unknown pipe line tied into the closure section. The time involved in closing two or three large valves and a few small ones, if the affected main is large, is not inconsiderable. Even three hours might be excellent time if several large valves must be closed manually. The need for valve operating equipment becomes obvious where many large valves are in use. This equipment may be truck mounted, driven from a power take-off, or it may be motor-driven from an air compressor or portable electric generator.

If the repair must be made at night, artificial light in generous quantity should be provided. Acetylene generators or portable electric generators should be available on the trucks answering night calls. The electric generators are probably the most satisfactory, since the entire site can be flooded with light from a very small amount of easily portable equipment.

If the excavation must be made through concrete, either a compressor with suitable tools or a gasoline-powered paving breaker should be available.

Where the pipe to be repaired is 20 in. or larger in diameter, the use of a truck-mounted crane, a common piece of contractor's equipment in a large city, will speed up both excavation and repair. A clam-shell bucket will make quick work of the wet excavation and the heavy pipe can be handled with ease. Tripod derricks made with 2-in. pipe legs will be strong enough for 20-in. pipe and fittings, if handled properly.

Self-priming gasoline engine centrifugal pumps are "musts" on speedy repair work. Rather than purchasing trailer-mounted pumps, it will be advisable to put the same amount of money into smaller, more readily portable units, using two or more on a large repair job. If one small pump fails, the job still goes on. If a large pump fails, the repair job stops until the pump can be made operative.

When the pipe to be repaired must be cut, the use of a pipe cutting machine may be advantageous. The cutting time can be shortened by using an air motor for power. A heavy duty electric drill or flue roller can also be used for power, being driven by a portable electric generator of $1\frac{1}{2}$ kw. or greater capacity.

With the pipe excavated and de-watered, the remaining work may take considerable time if lead joints and solid sleeves are used in making the repair. The use of mechanical joint solid and split sleeves, or a combination of them, will speed the job a great deal more.

Mechanical Joint Repair Fittings

With the use of mechanical joint repair fittings, the valve closures do not have to be as good as when poured joints are used. Neither does the excavation have to be as completely de-watered, since the bolt-fastened joints can be made under water, if necessary. Also, pipe ends do not have to be carefully cut off. Fittings are available which will cover jagged pipe ends with ease.

While cast-iron pipe, as a rule still uses the bell and spigot method, the use of mechanical joint fittings for making repairs is becoming comparatively common. The higher cost of these fittings as compared with poured joint fittings is largely offset by the saving in labor cost due to shortening of the time of repair. One man less is generally required on the repair crew since there is no need for a lead man. The use of mechanical joint fittings will receive a boom during this war emergency, but the increased use of these fittings is here to stay.

With the possibility that numerous repair crews may have to be put in the field at one time, if multiple incidents occur, these crews will necessarily be smaller than usual or the men will be inexperienced. The use of

mechanical joint fittings will allow inexperienced men to make good repairs after very little training, while it would take a great deal more time to develop lead melters and calkers.

Wood Plugs for Temporary Repairs

Wood is often an excellent material to use in making temporary repairs. Small holes can be stopped with wood plugs. These plugs can be sawed off flush, drilled out with a tapping machine and the permanent repair made with a brass plug.

In some cities, properly tapered wood plugs are used to plug the ends of 4-, 6- and 8-in. mains. The plugs, of course, must be blocked or otherwise secured to keep them in position when pressure is built up in the main. The use of wood plugs offers a very quick way to stop water wastage where a number of small mains, 4 to 8 in. in size, are broken. If found desirable, these plugs could be bored and smaller steel pipes driven into the plugs so that connections between ends of severed mains could be made temporarily with hose.

One way to minimize the time required to make water main repairs is to have the necessary materials stored as near the repair job as possible. Since it is impossible to know where the emergency will occur, the best procedure is to have small but adequate stocks of pipe and fittings stored at various points on the distribution system. It will then be unnecessary for the repair truck to go to a central storeyard, often several miles from the broken main, to get the necessary materials. Whenever anything is removed from one of these materials caches, it should be reported and immediately replaced. All crews should carry lists showing the amounts of material available at each place.

Sterilization of Repaired Mains

Sterilization is essential after distribution system repairs are made. The valves which were closed to segregate the affected portion of the distribution mains should not be opened as soon as the repair is made. The crew foreman or other responsible man will have to study the piping layout to determine how the probably contaminated section can be properly flushed and then sterilized. After flushing, hypochlorite or other chlorine solution should be fed into one end of the affected piping and allowed to disperse through the section by drawing water from the other end. After an adequate contact period, while the water in the main contains from 50 to 100 ppm. of chlorine, the main should again be flushed before being placed in service. In sterilizing and flushing, it may be necessary to close down one or more additional valves to get fire hydrants into the affected portion of the pipe system so that proper flushing and sterilizing can be done.

Foremen's schools may be necessary to teach the proper procedures in flushing and sterilizing mains. A number of problems involving repairs at selected spots in the distribution system will convey to the foremen the procedures to be followed. It is difficult to state categorically just how sterilization should be done. A dozen different procedures might have to be followed in a single distribution system, depending upon the spacing of hydrants and valves.

Equipment for sterilizing must be provided. Small iron force pumps with rubber check valves are fine for sterilizing small mains with hypochlorite solution. Larger mains will require power pumps with large solution crocks or gas-feeding equipment. Since similar equipment is necessary in sterilizing newly laid mains, the purchase or construction of these items can not be considered to be an extravagance.

Radio communication should be utilized wherever possible. Due to the present impossibility of constructing new short wave stations, the best chance is the use of police radio assistance where it can be obtained. While two-way communication will not be possible under most circumstances, receivers can be had or converted to use so that medium high frequency police stations can be received. It should be borne in mind that radio may not be worth a great deal if telephone service is gone, since it may be very difficult to get messages from the water department to the police department broadcasting station. Messenger service may have to be planned.

Discussion by *Bernard W. Cullen.** Perhaps the best discussion of Mr. Weir's very practical paper will be a description of the application of his various recommendations in the emergency repair program of a large city.

With the coming of war, Chicago's Mayor, acting in his capacity of Civilian Defense Co-ordinator of the Metropolitan District of Chicago, issued instructions to all city departments to co-operate with the OCD in making detailed defense plans. Commissioner of Public Works, Oscar E. Hewitt, who was appointed Chief of the Public Works Section, therefore ordered City Engineer W. W. DeBerard to start work on arranging a defense program.

All available information from magazines, newspapers and the reports of observers in the bombed countries were reviewed and found to indicate the inadvisability of using volunteer workers for utility repair work. It was planned, therefore, to build each emergency program around the experienced staff of each city-owned utility.

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Following a line of reasoning similar to that of Mr. Weir, the staff of the Water Pipe Extension Division, which has direct responsibility for the Chicago distribution system, from pumping station to consumer, went on an "Emergency Defense Basis" designed to meet the demands of any possible conditions arising from the war.

The Water Pipe Extension Division operates from three district headquarters from which the design, operation and maintenance of the distribution system are carried on by regular city employees. All construction work on the distribution system is also done by city day labor, providing a large reservoir of trained supervision, mechanics and laborers, for any emergency. The general supervision and record keeping are carried on from the Superintendent's office in City Hall and the present average total force employed by the division is 1,500.

Notification of Personnel

First consideration in planning the defense program was a means of notifying all employees of any impending attack. This was worked out as follows:

Through the OCD Control Center, notice of the coming attack is telephoned to the main office. Here a force of men who are on duty 24 hr. a day, in 8-hr. shifts, proceed to convey the message to the entire personnel by telephone in chain letter fashion; each man being responsible for notifying five others until the whole division has been contacted. For purposes of defense the city has been divided into seventeen subdistricts, each having a strategically located headquarters with a telephone and a reasonable supply of tools, equipment and materials. In establishing these headquarters, the location of feeder mains, pumping stations and barriers to transportation such as rivers, lakes and railroads, had to be taken into consideration, as did the location of centers of population. A balanced complement of employees living in the vicinity of each headquarters is assigned thereto so that when an "alert" is received every employee proceeds to this location and awaits orders. If, for any reason, the "alert" is not received, the sounding of sirens serves as notification.

During tests it has been found that within 32 min. all employees were notified and 77 per cent had already reported at their subdistricts. Since the "alert" warning is received in the main office 15 min. before the sounding of sirens, a good portion of the men have already assembled when the attack occurs and are ready to move to the scene of destruction. All available trucks and passenger cars are pressed into service to transport men, material and equipment to any part of the city. As there is no certainty that telephone services will be available during an attack, the division is arranging for the purchase of two-way radio equipment for

installation on trucks, at headquarters and in the automobiles of its key men, thus providing instantaneous contact with any desired unit. For the past five years this division has had an arrangement with the Chicago Police Department whereby it can contact any Water Pipe Extension Division Emergency Unit through the use of the police radio.

In the event that all normal means of communications have been put out of service by bombing, the Block Captain could designate messengers to contact the subdistrict Headquarters, Water Pipe Extension Division, in their respective districts, by automobile, bicycle or on foot notifying the man in charge of the location of the scene of the bombing.

Preparation for Emergency Conditions

To learn something of the capabilities of the division under such highly unusual conditions as presented by a bombing attack, a study has been made of all breaks which have occurred in the largest and most important mains in the water distribution system. By simulating the conditions of a bombing attack in connection with these actual breaks and taking into consideration the hindrances and loss of time occasioned thereby, it has been possible to arrive at some estimate of the number of such breaks which might be handled with the existing facilities and employees available. It has also shown what additional equipment will be needed, as no city is prepared during peacetime for the eventualities of total war. Because of priorities and financial restrictions, however, it is imperative that every community study all possible means of using "make-shift" equipment and substitute materials. The delay to the nation's war effort through orders for supplementary facilities which may prove unnecessary is also a prime factor in this consideration. The Water Pipe Extension Division has appointed a Materials Conservation Foreman who maintains contact with all districts of the division for the purpose of advising conservation methods and studying the possibilities of using salvaged materials. As a constant reminder to all concerned, signs bearing slogans for conservation have been posted conspicuously.

In a general way the division has made preparation for any unusual occurrence by submitting, to all of its employees, a questionaire requesting information as to each individual's capabilities aside from the work he is regularly assigned to. The knowledge thus gained has already been of great value in organizing for civilian defense work.

Since the Water Pipe Extension Division must co-ordinate its activities with those of the other departments, it has been careful to analyze and study all bulletins and instructions emanating from the Office of Civilian Defense. For example, all employees have been questioned, photographed and fingerprinted to test their citizenship and loyalty. Each employee

has been provided with a badge of identification, bearing his picture and number. He also carries a card of instructions at all times to identify and direct him during the emergency. Properly inscribed OCD armbands and motor vehicle insignia are provided so that air-raid wardens and auxiliary police will recognize them and allow them to proceed with their duties. All employees have been advised against engaging in other defense activities, such as block captain, air raid warden and the like.

Augmentation of Repair Personnel

To augment the division forces, officials are arranging with organized bodies, such as the Plumbing Contractors Association and the plumbers' union, whose work is closely related, to assist when called upon. All office forces are being trained in the operation of valves so that every employee will be useful if needed. In this connection it is pertinent to remark that the whole water distribution system has been platted for many years and the records kept up to date, showing the exact locations, types and sizes of all mains, valves, hydrants and appurtenances so that no time will be lost in finding them. Copies of these records are maintained at many strategic points. By using different valves for training the office employees, a double purpose was served, i.e., in addition to the training all gate valves were checked to make certain that they were in operative condition.

Drills have been held to rehearse employees in their duties following a bombing attack. These drills have included practice in the temporary restoration of feeder mains, construction of temporary pipe lines for domestic supply and proper sterilization of all parts affected. Assurance that a safe drinking water will be supplied through the temporary pipes is of paramount importance at all times and great stress has been laid upon the matter of sterilization. Arrangements have been made to obtain sprinkling trucks to distribute the water supply when circumstances require it. Needless to say, the closest co-operation is maintained with the fire department so that the maximum efficiency may be obtained in fighting fires.

The Water Pipe Extension Division Staff believes that, up to the limit of its present facilities, plus the supplementary facilities that would be obtainable, it is ready to care for many additional breaks due to bombings. In making arrangements for the use of additional equipment, all dealers and supply agencies as well as contractors and utility companies have been canvassed. There is now available a list of their equipment which it will be possible to use in the event of emergency.

Critical Problems in the Boiler Feed Water Field

By M. C. Schwartz

AT THIS particular time of all-out war effort, when power stations are loading their equipment beyond peacetime normal capacity and when outage for failure of equipment or even for maintenance is harmful to production, operating problems normally non-existent may arise for the first time or existing ones may be aggravated. Bailey (1) recently stated that there are still more outages for tube losses and for cleaning scale and sludge from boilers than from any other cause.

Many operating problems are introduced from the presence of certain substances in both the boiler feed water and the resulting steam produced, or even from the pure water and steam itself, supposing it were possible to remove all soluble or insoluble substances. It is obviously impossible to list all of the known cases but a few recent illustrations are mentioned. These are: cracking in boiler tube ends (2), carryover from lack of sufficient steam circulating tubes (3), condenser-tube scale (2), complex silicate boiler scales (4), carryover from a de-superheated system (2), pH control of phosphate-treated feed water to prevent scale in the boiler feed water system (5), hot spots or dry areas from inadequate water circulation (6, 7), corrosion from steam blanketed areas (6, 7), corrosion from excessive local alkalinity (8) and excessive adherent sludge deposits (8). An excellent general source of information on current operating problems is the subcommittee reports of the Prime Movers Committee of Edison Electric Institute.

It is not possible here to consider at any length all, or even many, of the operating problems introduced in the power plant by water and steam. However, one of the most important problems introduced by the use of high-pressure, high-make-up steam generating plants is carryover and its relationship to turbine deposits.

A paper presented on June 24, 1942, at the Chicago Conference by M. C. Schwartz, Louisiana State Univ. Eng. Expt. Station and Gulf States Utilities Co., Baton Rouge, La.

Carryover

Carryover from the boiler is a complex problem (9, 10, 11). Ordinarily carryover is considered as consisting of contamination of steam with boiler water. A layer of foam, or minute droplets of water, the existence and height of which are believed to be stabilized by the presence of certain soluble and insoluble substances in the boiler water, is presumed to exist in the boiler drum. As the steam enters the drum and passes upward or as the steam disengages itself from the liquid, it mechanically carries with it some of this layer of foam. This action, which is considered as going on continuously is frequently referred to as foaming. If the magnitude of this type of carryover becomes very great it is referred to as priming. However, a layer of "foam" could undoubtedly exist in the drum without the benefit of chemical stabilization, if steam releasing conditions in the drum were such as to entrain water by virtue of the high velocity and manner in which the steam passes through and out of the drum. That such is the case is proved in instances where steam purifying equipment has been able practically to eliminate the layer of foam ordinarily existing. Carryover by high velocity steam can be referred to as entrainment.

In spite of the complexity of the carryover problem and the absence of very clearly established causes, much progress has been made, practically, in diminishing its extent. Clearer recognition of the value of boiler operation with respect to changing load conditions, establishing maximum water levels, maximum boiler water dissolved solids, maximum boiler loads for given dissolved solids and water levels has helped much. Steam purifiers in the drum have improved conditions sufficiently even to warrant increased boiler capacity in some cases. The manner in which boiler water treatment can affect carryover is not too well established. Control of the boiler water alkalinity, both for reasons of controlled carryover and embrittlement, seems to be widely accepted.

The problem of carryover is in no way helped by the difficulty of measuring it. There seems to be a growing belief that the useful method of determining the electrolytic conductivity of the condensed steam must, at least, be supplemented by other methods which will enable the character of the carryover to be related to the nature of the turbine blade deposit. At the present time the laborious method of analyzing the residues from the condensed steam and the turbine blades themselves seems to offer the only direct attack on the problem.

Turbine Blade Deposits

The formation of turbine blade deposits (12, 13, 14), even with what appears to be very good control of boiler operation, feed water treatment and steam purity, is one of the most important problems of the high-pressure, high-make-up steam plant. The deposits which decrease the capacity and efficiency of the turbine require frequent washing in some instances. There seems to be no doubt that in many cases turbine washing is just as much a matter of routine as other steps more generally acknowledged. Whereas boiler deposits consist, for the most part, of combinations of calcium and magnesium compounds and sodium compounds only in the form of silicate complexes, turbine blade deposits consist of the sodium salts, which are soluble and silica which is insoluble, difficult to remove, and which is presumed to have originated from sodium silicate deposits on the blades.

One aspect of this turbine blade deposit problem which should be considered carefully is the so-called volatility of silica and boiler water salts. The term indicates that under the conditions of boiler temperature and pressure a very small but definite vapor pressure of silica or some other substance exists. The term volatility, however, seems to be ill-advised since what is meant is the "solubility" of the non-volatile boiler water salts in the steam. For example (15, 16), as the boiler temperature approaches the critical temperature of water, the solubility of the non-volatile component in the liquid phase decreases while its solubility in the vapor phase increases. At the critical temperature the two solubilities become the same. The critical temperature is raised by the presence of the solute. If the solubility of the solid is appreciable near the critical temperature, the resulting increase in the latter is marked. If this phenomenon actually occurs to a measurable extent, carryover will be expected to take place regardless of improvements in reducing foaming and entrainment.

The subject, the "solubility" of boiler water salts in steam, is by no means a simple one, even from the standpoint of experimental determination. Nieuwenburg and Blumendal (17) considered the system silica-water at 395°C. (300 atm. pressure) and showed a loss of silica depending on its crystalline form (quartz, cristobalite, tridymite, amorphous). Smits (18) discussed Nieuwenburg and Blumendal's work and Morey (19) attempted to repeat their work, but without success. Gillis claimed his work confirmed that of Nieuwenburg and Blumendal. Greig, Merwin and Shepherd (21) in support of Morey claimed that any transport of silica was due to experimental technique. Terzaghi (21) contributed to the discussion. Nieuwenburg and his associates (23, 24) repeated their work at 380°, 400°, and 425°C., pressures ranging from 293–500 atm.

They confirmed their previous work and gave values of the order of 0.4 mg. SiO_2 per ml. of steam. Preston and Turner (25) attacked the problem in a different manner showing that 1,400°C. was necessary for small but appreciable loss of silica. Dodd (26) conducted work similar to Preston and Turner. All of these studies are only of indirect interest to the practical problem.

Kleinhans (27) and Koch (28) considered the problem of the salt content of steam from a theoretical standpoint. Iskol'dskii (29) carried out experimental work with calcium, magnesium and sodium salts. Cleve (30), Spillner (31) and Fuchs (32) considered further the solvent action of high temperature water vapor. They stated that approximately below 80 atm. pressure, the salt content of steam is due to mechanical entrainment of boiler water; but above this pressure NaCl, KCl and NaOH are soluble in steam, the solubility depending upon the salt itself and the steam pressure, but being independent of the composition of the boiler water as long as enough of the salt is present to saturate the steam. Data secured by Spillner (31) are presented in Table 1. Splittgerber (33) presented experimental data (Table 2) on the silica concentration of steam at 50, 100 and 150 atm. pressure (263°, 309°, 340°C.). His results showed that the silica concentration in the steam increased with increasing silica concentration in the water, increased with increasing pressure and temperature and decreased in the presence of NaCl, Na_2SO_4, NaOH, and Na_3PO_4 in the water. Further evidence of the solubility of silica in the gaseous phase is presented by Ewell and Insley (34) who showed that

TABLE 1

"Solubility" of Salts in High-Pressure, High-Temperature Steam

COMPOUND	PRESSURE	TEMPERATURE	"SOLUBILITY"
	psi.	*°F.*	*mg/kg.*
NaCl	1,176	561	3.0
NaCl	1,470	590	5.5
NaCl	1,838	617	14.0
NaCl	2,205	646	34.0
NaCl	3,234	698	440.0
NaCl	3,234	765	260.0
NaOH	1,470	590	2.5
NaOH	1,838	617	5.5
NaOH	2,205	646	14.0
NaOH	3,234	698	150.0
Na_2SO_4	3,234	698	3.0

TABLE 2

"Solubility" of Silica in High-Pressure, High-Steam Temperature

COMPOUNDS IN "BOILER" WATER—PPM.	PRESSURE*	SiO_2† IN CONDENSATE
	psi.	*ppm.*
SiO_2 25	2,205	0.43
SiO_2 100	735	0.07
	1,470	0.15
	2,205	0.9
SiO_2 200	2,205	1.8
SiO_2 100 + NaCl 3,000	735	0.03
	1,470	0.05
	2,205	0.28
SiO_2 100 + Na_2SO_4 3,000	735	0.05
	1,470	0.05
	2,205	0.28
SiO_2 100 + NaCl 1,500 + Na_2SO_4 1,500	735	0.03
	1,470	0.05
	2,205	0.42
SiO_2 100 + P_2O_5 100	735	0.02
	1,470	0.05
	2,205	0.19
SiO_2 100 + NaOH 30	735	0.02
	1,470	0.18
	2,205	0.55
SiO_2 100 + NaOH 12,500	735	0.01
	1,470	0.01
	2,205	0.09
SiO_2 100 + P_2O_5 100 + NaOH bis	735	0.05
	1,470	0.05
	2,205	0.16

* 735 psi., 505°F.
1,470 psi., 588°F.
2,205 psi., 644°F.
† Values estimated by author from Splittgerber's graphical data.

silicates (beidellite-hydrous aluminum silicate) may be formed by reaction through transport of silica in the gaseous phase. Because of the great experimental difficulties involved in these types of investigation there is

still some question about the nature and magnitude of the results obtained. On one hand there is no doubt but that severe carryover has been experienced from high pressure boilers operating at about 1,200 psi. and higher, even with the knowledge and practice of the best information available. The solubility of boiler salts in the steam may be one aspect of the general problem to be considered at greater length in the future.

There are, however, a great many power plants operating at comparatively low pressures where carryover due to solubility of salts in the steam could not be expected to be of practical significance. Any working hypothesis for the formation of turbine blade deposits will have to explain their deposition, which presumably is not affected so readily by pressure and temperature drop as in the case of the highly superheated steam.

Before the answer as to the mode of turbine blade deposits is fully understood, more information as to the exact chemical nature of the deposit, particularly with respect to silica, will have to be secured. As far as the other components of turbine blade deposits are concerned, experience seems to show that they are soluble and readily washed off. The first portion of the problem—the manner in which the steam becomes contaminated with non-volatile substances has been considered. The other questions vital to the problem are: (1) Why should these substances precipitate out in the turbine? (2) Is the reactivity of silica, either as such or as a sodium silicate, different from that of the other substances?

Straub (35) suggested that the caustic in the steam is responsible for the adhesion of the other substances. Caustic within the range of 450–700° F. forms a sticky, concentrated liquid deposit which serves to collect the other dry substances unless they are present in sufficient excess to dry up the caustic. Straub made two suggestions for decreasing turbine deposits: (1) addition of carbon dioxide to the steam to change the caustic to the carbonate; (2) changing the composition of the boiler water by adding sodium sulfate, so as to change the ratio of Na_2SO_4:NaOH to approximately 4–5:1. The sodium sulfate treatment has been modified in patents of the I. G. Farbenindustrie A.-G. (36). In many plants carbon dioxide in reasonably high concentration exists as a volatile constituent, along with the steam. According to Straub, the carbon dioxide should tend to prevent deposits; on the other hand Hall and Kaufman (8) attribute the insoluble adherent deposits of silica to the action of carbon dioxide on sodium silicate and recommend minimizing the carbon dioxide content of the steam through feed water treatment. Hall recently stated that, although the solubility slopes of the different sodium salts vary in sign, the mixture usually present has only a positive slope and is liquid at and above boiler temperatures, precipitating in the turbine due to decreased solubility with decreased temperature.

As long as it is possible for silica to be present in the steam because of its solubility, the subsequent precipitation in the turbine because of decreased solubility may be a reasonable explanation of its existence as such in the deposits. A surface reaction between the iron of the blade and silica to form a tenaciously adhering film is possible. The well known existence of suspended iron oxide in saturated and superheated steam may be a factor in the problem. If the silica is being carried in the form of sodium silicate, however, the subsequent formation of silica is difficult to explain on the basis of presently available information (37).

Silica Removal

Closely associated with the behavior of silica in the turbine is the important problem of silicate boiler scales and the operating problems they have introduced in the high-pressure, high-make-up steam generating plant. Using published data as an index of activity it is readily seen that this problem, introduced in the early Thirties, assumed major importance in the latter half of that decade.

The formation of silicate scales (4, 38–42), the identity of which could only be determined exactly by x-ray diffraction analysis or petrographic analysis, of very low thermal conductivity on heating surfaces of maximum heat input, caused inevitable overheating of the boiler metal with resulting failure and boiler outage. Although there were several possible methods of attack for the solution of this problem, the one seeking to reduce the silica concentration in the feed water was probably investigated more widely than any other.

Extensive literature is available on the methods of removing silica from water. The author reviewed the material available prior to 1938 in a previous publication (43). Since that time there have been many articles covering this subject. It is sufficient to record them in the references cited (44–69).

The author is particularly interested at this time in reviewing methods for external silica removal used in actual practice.* Wherever possible silica removal is incorporated with the usual methods for clarification and softening. The two most widely used silica removal reagents are ferric and magnesium compounds, the latter being more frequently used. Aluminum compounds are also being used. Although it might be expected that only high-pressure, high-make-up steam generating plants would be

* The author is greatly indebted to Allis Chalmers Mfg. Co., W. H. & L. D. Betz, Cochrane Corp., Infilco, Inc., National Aluminate Corp. and Permutit Co. for furnishing the information for this review.

interested in silica removal, the process has been employed for 160-psi. boilers as well as for the higher pressure units up to 1,400 psi.

Considerable flexibility is available in the methods of silica removal. First consideration is given to the general water treatment to be adopted. Silica removal is then adapted to the process evolved. It may be interesting, first, to summarize the treatments actually in use. This is done in Table 3.

It is obvious that silica removal is widely used in connection with softening. Where lime is required for softening, part or all of it may be furnished by dolomitic lime. Dolomitic lime and magnesium oxide have been used together to furnish the required amount of magnesium. If the raw water

TABLE 3

Silica Removal

"COLD PROCESS"	"HOT PROCESS"
Clarification and Silica Removal	*Silica Removal*
1. Ferric sulfate (base)	10. Magnesium sulfate, caustic
2. Chlorinated ferrous sulfate (base)	*Softening*
3. Alum, sodium aluminate, lime	11. Dolomitic lime
Softening	12. Dolomitic lime, lime, soda ash
4. Dolomitic lime	13. Magnesium oxide, lime, soda ash
5. Dolomitic lime, lime, soda ash	14. Magnesium sulfate, caustic, phosphoric acid
6. Dolomitic lime, coagulant (ferric sulfate)	15. Lime, soda ash (high magnesium in water)
7. Dolomitic lime, magnesium oxide, coagulant	
8. Lime, soda ash (high magnesium in water)	
9. Lime, soda ash, coagulant (high magnesium in water)	

is sufficiently high in magnesium, complete precipitation of magnesium hydroxide in the softener may be all that is required. Silica removal may be carried out with magnesium compounds in conjunction with hot-process phosphate softening either where the latter is a further stage in the softening process or where it alone is used ($MgSO_4$). An interesting illustration of silica removal for low hardness waters is the use of phosphoric acid and magnesium sulfate, followed by degasification and then hot-process softening, at which stage caustic is introduced.

If the hardness of the water is so low that no softening is required or conditions such that the zeolite type of softening is used, magnesium sulfate (hot-process-caustic) or ferric sulfate may be used for silica removal. As far as the writer is aware, silica removal in two stages is practiced only

in one plant. Softening has been carried out in such units as the Infilco "Accelator," the Permutit "Spaulding Precipitator," and Cochrane and Permutit hot-process de-aerating softeners. Illustrations of these cases are presented in Table 4.

TABLE 4

Silica Removal

	COLD PROCESS										
	A	B	C	D‡	E‡	F	G	H	I	J‖	J‖
Initial Silica, ppm.	7	17	22	25	22	9	17	10	12	7.2	2.6
Final Silica, ppm.	3	3	6	2	6	2	2.5	1.5	3	2.6	1.6
Dolomitic Lime,* ppm.	65	290	230			400			377	45	
Ferric Sulfate, ppm.	10					20	200	170	17		25
Lime, ppm.			208				214	120		85	
Mg Hardness as $CaCO_3$, ppm. (raw water)				238	147						

	HOT PROCESS												
	M	N	O	P	Q	R	S	T	U	V	W‡	X§	Y§
Initial Silica, ppm.	24	48	19	24	7	23	6.5	34	42	57.5	20.5	11	17
Final Silica, ppm.	2.6	3.0	0.8	1.0	2.0	5.5	3.2	1.0	4.0	5	1.5	1.0	3
Dolomitic Lime,* ppm.	120	185	200	90	46					200			
Magnesium Oxide,† ppm.						40	15	40	60				
Lime, ppm.	22		110	28									
Soda Ash, ppm.	45		74	75	91								
Magnesium Sulfate, ppm.												40	60
Mg Hardness as $CaCO_3$, ppm. (raw water)											130		

* Dolomitic lime is available commercially as such and as "Silimite" (The Allis Chalmers Co.) and as "Mag-De-Sil" (The Permutit Co.).

† Magnesium oxide is available as such and as "Remosil" (W. H. & L. D. Betz Co.).

‡ Plants D, E and W are lime-soda ash softeners. Chemical dosage for softening not available.

§ Plant X and Y—silica and hot-process phosphate softening take place concurrently.

‖ Plant J—two-stage silica removal.

The factors involved in securing the maximum efficiency from the silica removal chemicals are reasonably well established. For the ferric compounds, pH control is necessary for optimum silica reduction; silica reduction is rapid; temperature does not play an important part, high temperatures acting somewhat adversely; and sludge recirculation may not be of much benefit. For the magnesium compounds, pH control is not critical; complete precipitation of magnesium as the hydroxide is necessary; soluble or ionic magnesium is more efficient than insoluble magnesium compounds; silica reduction is slow, particularly at low temperatures; temperature plays a very important part, the higher the temperature the more effective the removal; sludge recirculation is important; and high turbidity acts adversely. When dolomitic lime and magnesium oxide are used, the gross concentration of magnesium, consisting as it does of little soluble magnesium and mainly of insoluble magnesium, must be built up to what normally might be considered as tremendous concentrations. The use of the modern chemical-treating softening tanks, employing relatively large volumes of slow-moving sludge or smaller volumes of rapidly recirculating sludge, enable this to be done. There is no question but that the effective removal of silica by magnesium compounds was made possible in large part by the simultaneous development of such chemical treatment tanks. Assuming then that a very great portion of the magnesium is insoluble and does not become used up during the time available for reaction, it is apparent that a recirculation of this material for further reaction is advisable. This will be especially helpful if it is possible to treat the recirculated magnesium sludge so as to increase the concentration of dissolved magnesium, e.g., by introducing it into or mixing it with the lowest pH water available. One point of controversy seems to be the effect of phosphate ions on silica removal by either ferric or magnesium compounds. If hot-process phosphate softening is the only stage of softening required, there does not appear to be any valid reason, economically speaking, why both softening and silica removal should not take place together. If, however, two stages of hot-process softening, or a possibility of hot-process phosphate softening *vs.* zeolite softening are to be considered, experimental determination of the actual silica reduction to be obtained in all the possible cases appears to be the only safe procedure at this time.

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(*For References see following pages*)

References

1. Bailey, E. G. Maximum Output From Existing Boiler Plants. Midwest Power Conference (Apr. 9, 1942).
2. Hall, R. E., Partridge, E. P. and Daugherty, T. H. Routing Nightmares of Water Conditioning. Mech. Eng., **61:** 715 (1939).
3. Brown, E. M. Adding Circulating Tubes Reduces Moisture in Steam. Power, **78:** 76 (1934).
4. Powell, S. T., Carpenter, L. V. and Coates, J. J. Complex Silicate Scales in High-Pressure Boilers. Combustion, **11:** 18 (1939).
5. Powell, S. T., McChesney, I. G. and McChesney, Henry F. Boiler Feed Water Treatment at a High-Pressure Station. Ind. Eng. Chem., **30:** 400 (1938).
6. Straub, F. G. and Nelson, E. E. Corrosion in Partially Dry Steam-Generating Tubes. Mech. Eng., **61:** 199 (1939).
7. Partridge, E. P. and Hall, R. E. Attack on Steel in High-Capacity Boilers as a Result of Overheating Due to Steam Blanketing. Trans. A.S.M.E., **61:** 597 (1939).
8. Hall, R. E. and Kaufman, C. E. Co-ordination of Water Conditioning With Operating Problems. *Parts I and II.* Power Plant Eng., **45:** 8: 61; **45:** 9: 59 (1941).
9. Powell, S. T. Steam Contamination. Combustion, **9:** 3: 36; **9:** 4: 27; **9:** 5: 25 (1937).
10. Power Station Chemistry Subcommittee Report, Prime Movers Committee. Edison Electric Inst. (1940).
11. Tray, S. E. Boiler Operation as It Affects Prime Movers. Mech. Eng., **60:** 475 (1938).
12. Splittgerber, A. The Behavior of Boiler Water Salts in Superheaters and Turbines. Vom Wasser (Ger.), **12:** 366 (1937).
13. Schone, O. Salt Deposits in High-Pressure Turbines. Z. Ver. Deut. Ing. (Ger.), **79:** 1473 (1935).
14. Goerke, H. Salt and Silica Deposits in Steam Turbines. Elektrizitatswirtschaft (Ger.), **38:** 614 (1939).
15. Hitchen, C. S. A Method for the Experimental Investigation of Hydrothermal Solutions, With Notes on Its Applicability to Silica. Bul. Inst. Mining Met., No. 364: 1; No. 365: 1; No. 366: 29; No. 375: 1 (1935).
16. Keevil, N. B. Vapor Pressure of Aqueous Solutions at High Temperatures. J. Am. Chem. Soc., **64:** 841 (1942).
17. Nieuwenburg, C. J. van and Blumendal, H. B. The Volatility of Silicic Acid With Water Vapor. Rec. Trav. Chim. (Neth.), **49:** 857 (1930).
18. Smits, I. A. System: Water-Silicon Dioxide. Rec. Trav. Chim. (Neth.), **49:** 962 (1930).
19. Morey, G. W. Volatility of Silica With Steam. Trans. Am. Geophys. Union, **13:** 269 (1932).
20. Gillis, J. Volatilization of Silicon Dioxide and of Copper in Steam. Natuurw. Tijdschr. (Belg.), **15:** 153 (1933).
21. Greig, J. W., Merwin, H. E. and Shepherd, E. S. Notes on the Volatile Transport of Silica. Am. J. Sci., **25:** 61 (1933).
22. Terzaghi, R. D. The Volatile Transport of Silica. Am. J. Sci., **28:** 391 (1934).

23. NIEUWENBURG, C. J. VAN AND BLUMENDAL, H. B. The Volatility of Silica in Steam. Rec. Trav. Chim. (Neth.), **53:** 476 (1934).

24. NIEUWENBURG, C. J. VAN AND ZON, P. M. VAN. Semi-Quantitative Measurements of the Solubility of Quartz in Supercritical Steam. Rec. Trav. Chim. (Neth.), **54:** 129 (1935).

25. PRESTON, E. AND TURNER, W. E. S. Volatility of Silica. J. Soc. Glass Tech., **18:** 222 (1934).

26. DODD, A. E. Action of Water Vapor on Silica Bricks at High Temperatures and Its Possible Industrial Significance. Trans. Ceram. Soc., **35:** 223 (1936).

27. KLEINHANS, A. The Vaporization of Boiler Salts. Arch. Warmewirt. (Ger.), **17:** 127 (1936).

28. KOCH, B. The Evaporation of Boiler Salts. Warme (Ger.), **60:** 525 (1937); **61:** 219 (1938); Feuerungstech. (Ger.), **26:** 12 (1938).

29. ISKOL'DSKII, I. I. Volatility of Salts With Steam. J. Applied Chem. (U.S.S.R.), **12:** 17 (1939).

30. CLEVE, K. The Salt Content of Steam Produced by Steam Boilers. Z. Ver. Deut. Ing. (Ger.), **84:** 789 (1940).

31. SPILLNER, F. High-Pressure Steam as a Solvent. The Cause of Salt Carryover in Steam From High-Pressure Boiler Plants. Chem. Fabrik (Ger.), **13:** 405 (1940).

32. FUCHS, O. Superheated Water Vapor as a Solvent. Z. Electrochem. (Ger.), **47:** 101 (1941).

33. SPLITTGERBER, A. The Volatility of Silicic Acid. Arch. Warmewirt. (Ger.), **22:** 66 (1941).

34. EWELL, R. H. AND INSLEY, H. Hydrothermal Synthesis of Kaolinite, Dickite, Beidellite and Nontronite. J. Res., Natl. Bur. Stds., **15:** 173 (1935).

35. STRAUB, F. G. Cause and Prevention of Turbine-Blade Deposits. Trans. A.S.M.E., **57:** 447 (1935); Combustion, **7:** 6: 23 (1935); Univ. Ill. Eng. Expt. Sta. Bul. No. 282 (1936).

36. I. G. FARBENINDUSTRIE A.-G. French Pat. 802,429 (Sept. 4, 1936); British Pat. 464,403 (April 12, 1937); U.S. Pat. 2,204,522 (assigned to MAX WERNER AND HANS TIETZ).

37. BUCKLAND, B. O. Effect of Nozzle and Bucket Deposits on Turbine Capacity and Efficiency. Gen. Elec. Review, **45:** 2: 123 (1942).

38. HAERING, D. W. Silica Scale Prevention. Power Plant Eng., **42:** 331 (1938).

39. CLARK, L. M. AND BUNN, C. W. Scaling in Boilers. IV. Identification of Phases in Calcium Silicate Scales. J. Soc. Chem. Ind., **59:** 155 (1940).

40. FARMER, H. Silica in High-Pressure Boiler Water. Trans. A.S.M.E., **63:** 721 (1940).

41. PETERS, W. F. AND TURNER, W. D. Silica in Boiler Feed Water. Power Plant Eng., **44:** 3: 54; **44:** 4: 47 (1940).

42. SPLITTGERBER, A. The Chemical Properties of Silicic Acid in Aqueous Solution and Its Influence on High-Pressure Boiler Operation. Chem. Fabrik (Ger.), **13:** 169 (1940).

43. SCHWARTZ, M. C. The Removal of Silica From Water for Boiler-Feed Purposes. The Ferric Sulfate and Hydrous Ferric Oxide Process. Jour. A.W.W.A., **30:** 659 (1938).

44. GEISLER, W. Silica Removal From the Feed Water of the High-Pressure Plant in Hochst. Vom Wasser (Ger.), **12:** 381 (1937).

45. Wesly, W. and Geisler, W. Experiences in Feeding High-Pressure Boilers With Chemically Treated Water. Chem. Fabrik (Ger.), **10:** 197 (1937).
46. Holl, K. Removal of Silica From Raw Water. Arch. Warmewirt. (Ger.), **19:** 323 (1938).
47. Permutit, A.-G. Softening of Water With Simultaneous Removal of Silica. German Pat. 654,503.
48. L'Auxiliaire des Chemins de Fer et de l'Industrie and Geza V. Austerweil. Eliminating Silica From Water. French Pat. 843,663 (July 7, 1939); British Pat. 526,254 (Sept. 13, 1940).
49. Etablissements Philips and Pain. Eliminating Silicic Water From Water. French Pat. 849,369 (Nov. 22, 1939).
50. I. G. Farbenindustrie, A.-G. Eliminating Silicic Acid From Water. French Pat. 848,885 (Nov. 8, 1939).
51. Kaissling, F. Silica Deposits in Steam-Turbines. Arch. Warmewirt. (Ger.), **20:** 89 (1939).
52. Lindsay, F. K. and Ryznar, J. W. Removal of Silica From Water by Sodium Aluminate. Ind. Eng. Chem., **31:** 859 (1939).
53. Splittgerber, A. Silicic Acid and Its Meaning in High-Pressure Boiler Operation. Mitt. Ver. Grosskesselbesitzer (Ger.), No. 73: 206 (1939).
54. Wesly, W. Chemically Treated Feed Water for High-Pressure Boilers. Wasser (Ger.), **13:** 155 (1939); Chem. Fabrik (Ger.), **12:** 137 (1939).
55. Behrman, A. S. and Gustafson, H. Removal of Silica From Water. Ind. Eng. Chem., **32:** 468 (1940).
56. Betz, L. D., Noll, C. A. and Maguire, J. J. Removal of Silica From Water by Cold Process. Ind. Eng. Chem., **32:** 1320 (1940).
57. Betz, L. D., Noll, C. A. and Maguire, J. J. Removal of Silica From Water by Hot Process. Ind. Eng. Chem., **32:** 1323 (1940).
58. Lindsay, F. K. and Braithwaite, D. G. (*to* National Aluminate Corp.). Removing Silica From Silica-Containing Water. U.S. Pat. 2,194,525 (Mar. 26, 1940).
59. McBrian, Ray *et al.* Removal of Silica From Boiler Feed Water. Bul. Am. Ry. Eng. Assn., No. 414: 101 (1940).
60. Peters, W. F. Boiler Water Treatment. Universal Engr., **71:** 2: 27 (1940).
61. Peters, W. F. and Turner, W. D. Silica in Boiler Feed Water. Power Plant Eng., **44:** 3: 54 (1940).
62. Tray, S. E. and Pankey, T. L. Removal of Silica From Industrial Boiler-Water Supplies. Combustion, **12:** 5: 39 (1940).
63. Wesly, W. The Preparation of Feed Water Free of Silicic Acid and Hardness. Chem. Fabrik (Ger.), **13:** 85 (1940).
64. Applebaum, S. B. Water Treatment for Chemical Impurities. Power Plant Eng. **45:** 74 (1941).
65. Betz, L. D., Noll, C. A. and Maguire, J. J. Adsorption of Soluble Silica From Water. Ind. Eng. Chem., **33:** 814 (1941).
66. Betz, L. D., Noll, C. A. and Maguire, J. J. Adsorption Process for Removal of Soluble Silica From Water. Trans. A.S.M.E., **63:** 713 (1941).
67. Yoder, J. D. Silica in Boiler Feed Water and Methods for Its Removal. Southern Power & Ind. **59:** 2: 103 (1941).
68. Liebknecht, O. and Gerb, L. Removing Silica From Water. U.S. Pat. 2,267,831 (Dec. 30, 1941).
69. Tiger, H. L. Silica Removal by an Improved Magnesia Process. Trans. A.S.M.E., **64:** 49 (1942).

A New Method of Determining Residual Chlorine

By H. C. Marks and J. R. Glass

MOST of the limitations of known methods of determining residual chlorine in water result from the fact that the solution is acidified during the determination. These errors, due to acidification, have been investigated by Scott and others, (1, 2, 3, 4) who show the desirability of determining residual chlorine in neutral solution. Determinations in neutral solution are often made by titration with sodium thiosulfate. Since there are several possible reactions between sodium thiosulfate and chlorine in neutral solution (5, 6), this titration cannot be classed as a quantitative determination of residual chlorine.

The titration of chlorine with sodium arsenite in neutral solution has been investigated and found to proceed according to a single quantitative reaction (7). Thus, residual chlorine can be titrated accurately with sodium arsenite in neutral solution if there is available a means of indicating the end-point of the titration. The starch iodide end-point may be used if a known amount of standard sodium arsenite solution is added to the sample and the amount not consumed by the chlorine is determined by titrating with standard iodine solution (8). This method, however, is inconvenient and the starch iodide end-point is not sensitive enough to permit the accurate determination of low residuals. The end-point of certain titrations may be determined by means of the dropping mercury electrode and in certain cases by means of a very small platinum electrode (9), by a modification of the polarographic method. Kolthoff and Pan have called such determinations amperometric titrations (10). The method here presented is a type of amperometric titration employing electrodes especially designed to permit the convenient determination of residual chlorine in water. An amperometric titration differs from a conductometric and a potentiometric titration in that it utilizes the phenomenon of electrode polarization.

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Apparatus and Method

When two electrodes are placed in contact with a solution and an electrical voltage is impressed across the two electrodes, the current can flow in the circuit only if the voltage is sufficiently great to cause chemical reaction at both electrodes. The chemical reaction at the positive electrode is oxidation; that at the negative electrode is reduction. Current can flow only if oxidation occurs at the positive electrode and reduction

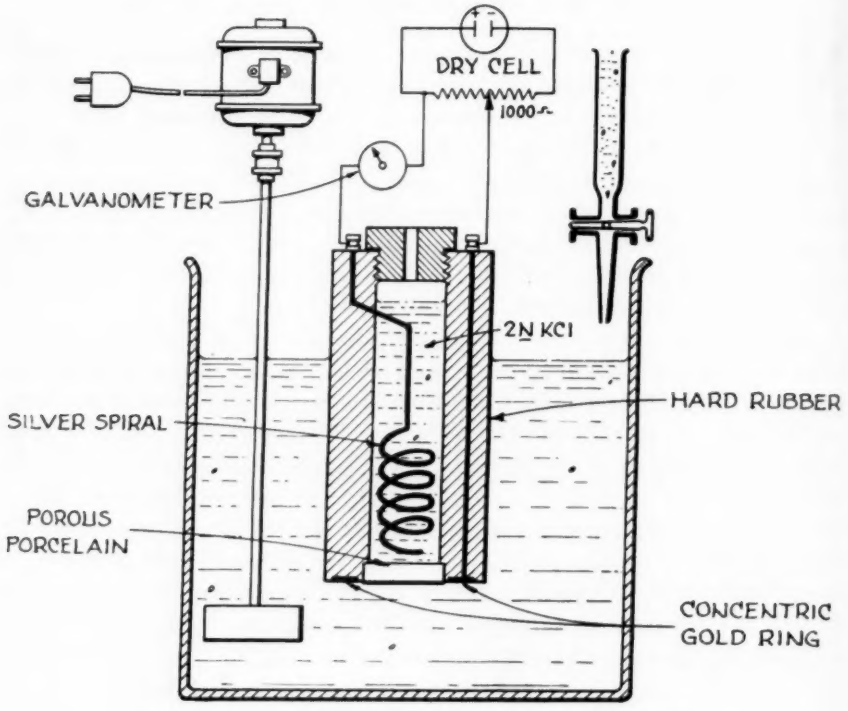

FIG. 1. Apparatus for Determining Residual Chlorine

occurs at the negative electrode. With a given impressed voltage, these reactions are possible only if the proper reducing agent is in contact with the positive electrode and if the proper oxidizing agent is in contact with the negative electrode. In the determination of oxidizing agents, such as chlorine, a large, easily oxidized, positive electrode is used. Then, under the proper conditions, the current that can flow will depend only upon the concentration of the oxidizing agent which is reduced at the negative electrode.

With such an arrangement as an indicator, chlorine can be titrated with

a standard solution of sodium arsenite. The chlorine present allows current to flow. The arsenite added reduces the chlorine. Thus, less chlorine is present and less current flows. Each addition of arsenite produces a decrease in current as long as chlorine is present. When all the chlorine is reduced, further addition of arsenite causes no change in current and thus determines the end-point of the titration.

The dropping mercury electrode is not directly applicable to the titration of residual chlorine, as it is not sensitive enough to permit determination of the low concentrations of chlorine usually encountered in water; and unless a considerable amount of strong electrolyte is added, the low conductivity of the water causes extraneous changes in current as the reducing agent is added.

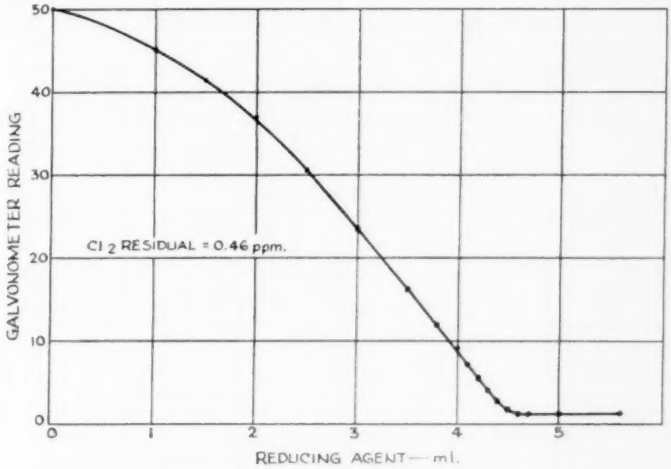

FIG. 2. Typical Titration Curve

The apparatus shown in Fig. 1 was designed to avoid these difficulties. The positive electrode is a silver wire, surrounded by 2*N* potassium chloride. At this chloride ion concentration the silver is readily oxidized to silver chloride by the passage of the electric current, so that the concentration of available chlorine in the solution surrounding the gold cathode determines the amount of current. The efficiency of the agitation at the surface of the gold cathode is highly important because it determines the sensitivity of the method. This must be high, particularly in carrying out titrations at low temperature. The circuit is completed through the porous porcelain diaphragm, which is located close to the gold cathode so as to minimize the effects of changes in conductivity. As the titration proceeds the current change is observed as a movement of the galvanometer needle.

In Fig. 2 is shown a typical curve, wherein galvanometer reading is plotted against the volume of reducing agent added. After the end-point has been reached no further change in the galvanometer reading can be produced by adding more reagent. It is not necessary to plot readings in practice, as the end-point can be determined merely by observing the galvanometer.

Reaction of Arsenite With Chloramines

Although the reaction between chlorine and sodium arsenite was known to be quantitative, nothing was known about the reaction between sodium arsenite and chloramines. Preliminary experiments showed that the amperometric titration method sometimes gave considerably lower results than those obtained by the ortho-tolidine method. The presence of ammonia in these cases was confirmed. When water distilled from phos-

TABLE 1

Effect of pH on the Titration of Available Chlorine in Ammonia-Free Water

pH	CHLORINE RESIDUAL (PPM.)		
	Amperometric Titration		Ellms & Hauser Ortho-tolidine Method
	KI Absent	KI Added	
6.0	0.41	0.43	0.47
6.5	0.36	0.38	0.40
7.1	0.37	0.39	0.44
7.5	0.43	0.44	0.47
8.0	0.40	0.41	0.46
9.0	0.35	0.36	0.40

phoric acid was used the results obtained checked well with the ortho-tolidine method. Chlorinated water containing ammonia in excess of that necessary to form chloramines, however, gave no titration although the ortho-tolidine method showed residual chlorine to be present. These results indicate that sodium arsenite reacts rapidly with free hypochlorous acid, but does not react at an appreciable rate with chlorine that is combined with ammonia in the form of chloramines. It was then found that the reaction between chloramines and sodium arsenite would occur if it were activated by the presence of potassium iodide (KI). Thus, when chlorinated water containing ammonia in excess of that necessary to form chloramines was titrated with sodium arsenite after the addition of potassium iodide (KI), the titer obtained checked well with determinations made by the ortho-tolidine method showing that sodium arsenite will react quantitatively with chloramines if potassium iodide (KI) is present.

In Table 1 are shown the results of the determinations made using water distilled from phosphoric acid and buffered to various pH values by means of phosphate buffers. It will be noted that the titer obtained after the addition of KI is slightly higher in all cases. This difference is attributed to the fact that there is probably about 0.005 ppm. ammonia present even in this carefully prepared water. It is evident that the Ellms and Hauser ortho-tolidine standards (11, p. 19) give somewhat higher results. This fact will be discussed later.

In Table 2 are shown the results of similar determinations in which 0.2 ppm. of ammonia was added to the water. In all cases, the titer before the addition of KI was zero, indicating that sodium arsenite does not reduce chloramines. It is evident that results obtained after the addition of KI checked well with standard methods.

TABLE 2

Titration of Available Chlorine in the Presence of Excess Ammonia at Various pH Values

(NH_3 Concentration = 0.2 ppm.)

pH	CHLORINE RESIDUAL (PPM.)	
	Amperometric Titration (KI added)*	Ellms & Hauser Ortho-tolidine Method
5.5	0.41	0.42
6.0	0.42	0.42
6.5	0.42	0.43
7.0	0.42	0.45
7.5	0.43	0.44
8.0	0.49	0.50
8.5	0.49	0.48

* All titrations without the addition of KI were zero.

On the basis of Chapin's (12) results on the formation of mono- and dichloramine at various pH values, and the results given in Tables 1 and 2, it can be concluded that this method permits the separate determination of hypochlorous acid on the one hand and of mono- or dichloramine on the other hand.

Experimental Procedure

The stock arsenite solution is prepared by adding 25 ml. of 10*N* NaOH to 19.79 g. of arsenious oxide (Baker's Analyzed Reagent) in a beaker. This solution is transferred to a 1-l. volumetric flask to which has been added 40.8 g. (0.3 moles) of KH_2PO_4 and 71.6 g. (0.2 moles) of $Na_2HPO_4 \cdot 12H_2O$. Sufficient distilled water is added to dissolve the salts and finally the solution is diluted to 1 l. with distilled water.

This stock arsenite solution is 0.400*N* as can be shown by titrating it with standard iodine solution. In agreement with other observers (13), it has been found to be stable over a period of years. Solutions for use in titrating residual chlorine are made by diluting* this stock solution with distilled water. It is convenient to use a 0.00282*N* solution and a 1-l. sample. Then each milliliter of arsenite corresponds to 0.1 ppm. of residual chlorine.

A 0.0564*N* potassium iodide solution is prepared by dissolving 9.36 g. of potassium iodide (Baker's Analyzed Reagent) in distilled water and diluting to 1 l.

Titrations were made with samples of convenient size—250 ml. or 1,000 ml.—the end-point being determined by observation of the galvanometer. The determination of hypochlorous acid and chloramines was made on the same sample. After the hypochlorous acid was titrated, 0.5 ml. of potassium iodide solution (KI) was added and the titration was continued until a second end-point was reached. The 1,000-ohm potentiometer shown in Fig. 1 was adjusted so that the current through the galvanometer would be about 1 or 2 μa. when the second end-point was reached.

Reagents used for the determination of nitrites were made up according to *Standard Methods* (11, p. 133).

Comparison With Other Methods

In Table 3 are given the results of determinations made over the range of residuals usually encountered, using distilled water buffered at pH 7.1. Residual chlorine was determined by the amperometric titration method, using KI, by the Ellms and Hauser ortho-tolidine method (11, p. 19) and by the ortho-tolidine method of Muer and Hale (14). Here, as in Table 1, the results obtained using the Ellms and Hauser ortho-tolidine method, are somewhat higher than by the arsenite titration but results obtained using Muer and Hale's standards are in good agreement with the arsenite titration. These results are to be expected, since Muer and Hale (14) have shown that Ellms and Hauser (15) did not use a water having zero chlorine demand when they developed the color standards for ortho-tolidine which were adopted by *Standard Methods*.

In Table 2 showing determinations made on chloramines, however, it is evident that results obtained with the Ellms and Hauser ortho-tolidine method are not significantly higher than those obtained by the amperometric titration method. It is believed to be due to the fact that during

* Most of the dilute arsenite solutions are stable, but a few of them lose strength very rapidly, giving evidence of bacterial decomposition. Solutions made up with the addition of 2 ml. chloroform per liter have shown no change in strength for periods of several months.

the time necessary for full color development with chloramines, a small amount of chlorine is lost. In this particular case, this error, due to loss of chlorine, compensated for the error of the standard. In all cases, ortho-tolidine residuals were read at maximum color development. In the case of chloramines, this was 15 to 20 min. after the addition of ortho-tolidine.

Effect of pH and Temperature

It is evident from Tables 1, 2 and 3 that it is possible to determine free hypochlorous acid and chloramines accurately over a considerable pH range. It is easier, however, to titrate within the pH range of 6.5 to 8.0. At pH values below 6.5, with no KI added, the galvanometer responds

TABLE 3

Comparison of the Amperometric Titration With the Ortho-tolidine Method

(pH = 7.1)

CHLORINE RESIDUAL (PPM.)		
Amperometric Titration (KI added)	Ellms & Hauser Ortho-tolidine Method	Muer and Hale Ortho-tolidine Method
0.02	0.03	0.02
0.05	0.06	0.07
0.08	0.11	0.08
0.12	0.15	0.14
0.20	0.22	0.22
0.41	0.52	0.47
0.62	0.73	0.63
0.90	1.0	0.95
1.8	—	1.5
2.7	—	2.4
4.7	—	4.4
6.3	—	6.6
8.8	—	9.0

very slowly as each increment of arsenite is added. The same difficulty is encountered, with KI added, below pH values of 6.0. At pH values above 8.0, with no KI added, the change in current is not as great for each addition of arsenite; thus the exact end-point is not as easily determined. The same difficulty is encountered, with KI added, above pH 8.0. Furthermore, when ammonia is present difficulties are experienced due to the diminished activity of the KI at high pH values. These effects make the determination difficult and time-consuming although not inaccurate. In order conveniently to determine residual chlorine in waters outside the pH limits of 6.5 to 8.0, it is necessary to add a suitable buffer to the water before titrating, to bring the pH within the optimum range. When this is done a determination requires only a few minutes.

The effect of temperature upon the determination was studied over the range of 32 to 77°F. and the titration was found to give good results over the entire range studied. At very low temperatures, the response of the galvanometer was found to be slightly slower than usual; but this minor difficulty did not affect the accurate determination of the end-point.

Precision of the Method

To determine the precision of the method, tap water was treated with sodium hypochlorite and allowed to stand in the dark until the residual was changing at a very slow rate. A series of titrations was then run on 7 successive samples over a short period of time. With a chlorine residual of 0.44 ppm., all results were within 0.01 ppm.

Interfering Substances

Since the sodium arsenite titration is performed in neutral solution, it was expected that substances such as iron and manganese would not interfere. Experiments showed this to be the case. Water containing 1 ppm. of colloidal manganese dioxide gave no titration with sodium arsenite; and when this water was chlorinated, titrations showed the expected amount of residual chlorine to be present. The same results were obtained with water containing 1 ppm. of ferric iron. In addition to iron and manganese, the following substances were also found not to interfere with the determination: nitrates, nitrites, phosphates, sulfates, carbonates, borates, chlorides, hydrogen peroxide, calcium, aluminum and copper. In the presence of more than 1 ppm. of copper the response of the galvanometer was slow, making the titration difficult. The accuracy of the determination, however, was not affected by the presence of copper.

Thus, this new method may be found useful for determining residual chlorine in the presence of substances likely to interfere with determinations made by the usual methods. The determinations were found not to be affected by the color or turbidity of the solution.

Application to the Break-Point Reaction

One important application of the method of distinguishing between hypochlorous acid and chloramines is the study of the break-point process. The break-point phenomenon seems to depend upon the presence of an excess of chlorine above that necessary to form chloramines with the ammonia or ammonia-type compounds present (16). For this reason, a method which allows the direct determination of the extent of chloramine formation should be useful both for investigating the mechanism of the reaction and for the practical operation of the break-point process. Some preliminary work indicates that this promise may be borne out. For

example, in Fig. 3 are shown the results of a break-point experiment using buffered distilled water to which 0.5 ppm. ammonia was added. This experiment at 32°F. is typical of a number of others at this and at higher temperatures. It is seen that the plot of total residual *vs.* dose, after 1-hr. contact, shows the typical break-point. The curves showing free hypochlorous acid and chloramine after 5-min. contact are of particular interest. As the former increases and the latter decreases with dosage, they cross in the vicinity of the break-point, and beyond the break-point the free chlorine is in excess.

The same relation is observed with a water sample from the Millstone River, N.J., which is shown in Fig. 4. The natural break-point of the

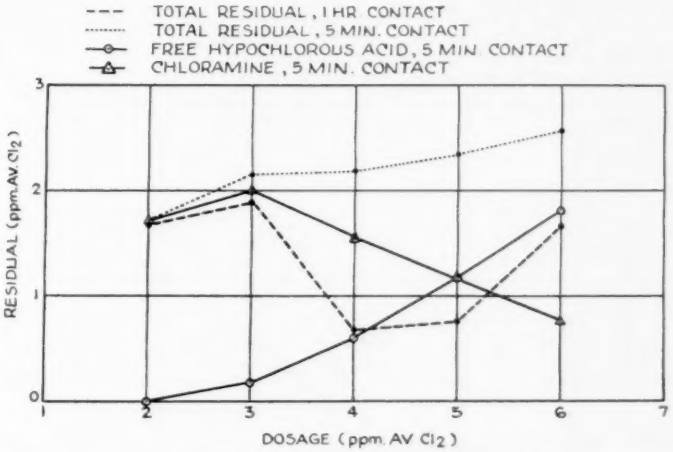

FIG. 3. Concentration of Free Hypochlorous Acid and of Chloramine Near the Break-Point—buffered distilled H_2O; pH, 7.9; temperature, 32°F.; 0.5 ppm. NH_3 added

water is shown in the curve of total residual *vs.* dosage for 1-hr. contact. Again, it is found that the hypochlorous acid is in excess of the chloramine for the 5-min. contact period after the break-point has been passed.

These examples show the desirability of testing this relationship in a large number of typical cases to determine whether the method can consistently indicate the position of a given chlorine dosage with respect to the break-point without waiting for the break-point reaction to occur.

Of interest in connection with the mechanism of the break-point reaction is the fact that the point at which the residual begins to break corresponds rather closely with the point where hypochlorous acid first appears. The actual reaction mechanism might be determined if it were certain that the sodium arsenite titration, in the absence of KI, determined only the hypo-

chlorous acid. There is also a possibility, however, that all or part of the chlorine present as nitrogen trichloride may be included in this so-called hypochlorous acid. The presence of nitrogen trichloride has been suspected because its odor is evident in the region of the break-point. The experimental results included in the following section confirm the presence of this substance.

Effect of Residual Chlorine on the Nitrite Reagent

Calvert (17) has reported that chlorine residual produces a false color with the nitrite reagent when the sulfanilic acid is added before the α-naphthylamine. He found that the intensity of the color increased with chlo-

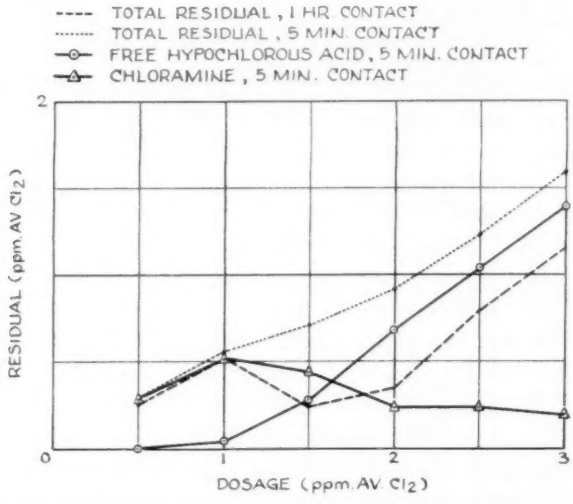

FIG. 4. Concentration of Free Hypochlorous Acid and of Chloramine Near the Break-Point, Millstone River, N.J.—pH, 7.4; temperature, 58°F.

rine dosage but that the pink color was not obtained if the α-naphthylamine was added first. These results have in general been confirmed, but as the ammonia concentration is decreased the intensity of the color decreases. In water which has been distilled from phosphoric acid the false color produced by a chlorine residual of 1.8 ppm. is barely perceptible (0.0008 ppm. nitrite nitrogen). From previous experiments it has been concluded that traces of ammonia are present even in water treated in this way. It is therefore unlikely that the residual chlorine alone is the cause of the false color.

The false nitrite color produced in solution containing ammonia and available chlorine is observed only when the chlorine and the ammonia solutions are freshly mixed. After about one hour's standing, the test

can no longer be obtained. Since there is undoubtedly chloramine present after this time, it cannot be responsible for the false color. That the false color is probably due to nitrogen trichloride is indicated by the results in Table 4. Here chlorine and ammonia were mixed at pH 3 deliberately to form nitrogen trichloride. It will be observed that very strong false colors are produced.

TABLE 4

Effect of Nitrogen Trichloride on the Nitrite Reagent

(pH = 3.0; NH_3 Concentration = 0.5 ppm.)

CONTACT TIME	COLOR WITH NITRITE REAGENT*	CHLORINE RESIDUAL
min.		*ppm.*
1	0.003	—
5	—	5.7
30	0.015	5.3
60	0.03	—
90	0.05	4.0
120	0.05	3.9
150	0.04	3.5

* Expressed as ppm. nitrite nitrogen. This color obtained only when the sulfanilic acid is added first.

TABLE 5

Amperometric Titration of Chloramine in the Presence of Nitrite

(pH = 7.0; NH_3 Concentration = 0.06 ppm.; 0.01 ppm. Nitrite Nitrogen added)

CONTACT TIME	NITRITE NITROGEN*		CHLORINE RESIDUAL
	Sulfanilic acid added first	α- naphthylamine added first	
min.	*ppm.*	*ppm.*	*ppm.*
0	—	—	0.14
2	0.008	0.008	—
10	—	—	0.14
30	0.007	0.006	0.13
90	0.007	0.006	0.13

* A control to which no nitrite was added contained 0.13 ppm. chlorine residual after 90 min.

The above results lead to the conclusion that nitrogen trichloride can produce a nitrite color with the standard nitrite reagent provided the sulfanilic acid is mixed before the α-naphthylamine is added. The additional conclusion may be drawn that some nitrogen trichloride is formed even in solutions containing excess ammonia at pH 7. There is a possibility that the nitrogen trichloride in these cases is formed when the solu-

tion is made acid by the addition of the nitrite reagent. This seems unlikely, however, for two reasons: (1) the reaction should occur with chloramine solutions regardless of age; and (2) nitrogen trichloride formation is not a rapid reaction as is shown by the data in Table 4.

That nitrites can be determined in the presence of chloramine residual regardless of the order of addition of the reagents and that the residual

TABLE 6

Reaction Between Nitrite and Chloramine

(pH = 7.0; NH_3 Concentration = 0.06 ppm.; 0.10 ppm. Nitrite Nitrogen added)

CONTACT TIME	NITRITE NITROGEN*		CHLORINE RESIDUAL
	Sulfanilic acid	α- Naphthylamine	
hr.	*ppm.*	*ppm.*	
0	—	—	0.14
1.5	—	—	0.12
3.0	0.05	0.06	0.09
19	0.04	0.05	0.02

* A control to which no nitrite was added contained 0.13 ppm. chlorine residual after 19 hr.

TABLE 7

Use of the Nitrite Reagent to Indicate Nitrogen Trichloride Near the Break-Point

(Buffered distilled H_2O; pH = 7.1; 0.5 ppm. NH_3 added)

CONTACT TIME	CHLORINE DOSAGE = 3 PPM.		CHLORINE DOSAGE = 4 PPM.		CHLORINE DOSAGE =5 PPM.	
	Nitrite color*	Chlorine residual	Nitrite color*	Chlorine Residual	Nitrite color*	Chlorine residual
min.		*ppm.*		*ppm.*		*ppm.*
1	0.002	—	0.005	—	0.011	—
5	—	1.7	—	1.7	—	2.0
30	0.0002	1.0	0.0025	0.5	0.008	1.0
60	0.0000	0.9	—	—	—	—
90	—	—	0.0015	0.3	0.007	1.0
150	—	—	—	—	0.006	1.0

* Expressed as ppm. nitrite nitrogen. This color obtained only when the sulfanilic acid is added first.

can also be determined accurately, are shown in Table 5. The solution contained 0.06 ppm. ammonia and a chlorine residual of 0.14 ppm. before adding 0.01 ppm. nitrite nitrogen. A part of the nitrite was consumed by the chlorine, but the results obtained are seen to be reasonable with respect to the initial concentrations. That the nitrite and chloramines react slowly is shown in Table 6, which gives the results when 0.10 ppm. nitrite

nitrogen was added to a solution containing 0.14 ppm. chlorine residual and 0.06 ppm. ammonia.

That nitrogen trichloride is actually present during the break-point reaction is shown in Table 7. In this experiment the reaction of nitrogen trichloride with the nitrite reagent was used as a means of detection and as a comparative measure of concentration. The color obtained by the addition of the sulfanilic acid solution and the α-naphthylamine solution is expressed as parts per million nitrite nitrogen. Only faint brown discolorations were obtained when the α-naphthylamine was added first. It is observed that the color and therefore presumably the nitrogen trichloride concentration increase with increasing dosage and decrease with time. It seems likely that nitrogen trichloride plays a major rôle in the break-point reaction and further experiments are being undertaken along this line.

Summary

A new method of determining residual chlorine in water has been presented. This method consists of titrating the chlorine amperometrically with sodium arsenite in neutral solution using a polarized gold electrode and a silver chloride reference electrode.

In the absence of potassium iodide only the free chlorine is titrated. This free chlorine is essentially hypochlorous acid. In the presence of potassium iodide both free and combined chlorine are titrated. Combined chlorine consists essentially of monochloramine and dichloramine. The determination of free and combined chlorine will probably be found useful in the treatment of water with chlorine and ammonia.

As the method is a direct titration, its accuracy is inherent. It is shown to give correct results within pH limits of 6.5 to 8.0, temperature limits of 32 to 77°F. and in the presence of most of the substances usually found in water, including those producing color and turbidity. The method is applicable to the determination of residuals less than 10 ppm. chlorine. The limit of sensitivity is 0.01 ppm. chlorine.

The interference of chlorine with the determination of nitrite is shown to be due to the presence of nitrogen trichloride. This interference is present only when the sulfanilic acid is added first.

The production of nitrogen trichloride occurs during the break-point process and is greatest at chlorine doses beyond the break-point.

References

1. Scott, R. D. Eliminating False Chlorine Tests. Jour. A.W.W.A., **26:** 634 (1934).
2. Scott, R. D. Effect of Iron in the Determination of Residual Chlorine. Jour. A.W.W.A., **26:** 1234 (1934).
3. Griffin, A. E. Evaluation of Residual Chlorine. Jour. A.W.W.A., **27:** 888 (1935).

4. Hopkins, Edward S. Manganese Interference in the *o*-tolidine Test for Available Chlorine. Ind. Eng. Chem., **19:** 744 (1927).
5. Hallinson, F. J. and Thompson, W. R. A Critical Study of the Thiosulfate Titration of Chlorine. J. Am. Chem. Soc., **61:** 265 (1939).
6. Willson, Virgil A. Determination of Available Chlorine in Hypochlorite Solutions by Direct Titration With Sodium Thiosulfate. Ind. Eng. Chem.—Anal. Ed., **7:** 44 (1935).
7. Treadwell, W. D. The Electrometric Titration of Hypochlorous Acid. Helvetica Chim. Acta. (Switz.), **4:** 396 (1921).
8. Sutton, Francis. *A Systematic Handbook of Volumetric Analysis.* J. & A. Churchill, Ltd., London (12th ed., 1935), p. 207.
9. Kolthoff, I. M. and Lingane, J. J. *Polarography.* Interscience Publishers, Inc., New York (1941), pp. 447-78.
10. Kolthoff, I. M. and Pan Yu-Djai. Amperometric (Polarometric) Titrations. I. The Amperometric Titration of Lead With Dichromate or Chromate. J. Am. Chem. Soc., **61:** 3402 (1939).
11. *Standard Methods for the Examination of Water and Sewage.* Am. Public Health Assn. & Am. Water Works Assn., New York (8th ed., 1936).
12. Chapin, R. M. Dichloro-amine. J. Am. Chem. Soc., **51:** 2112 (1929).
13. Washburn, Edward. The Theory and Practice of the Iodometric Determination of Arsenious Acid. J. Am. Chem. Soc. **30:** 31 (1908).
14. Muer, H. F. and Hale, F. E. Readjustment of Present Ortho-tolidine Standards for Chlorine. Jour. A.W.W.A., **13:** 50 (1925).
15. Ellms, J. W. and Hauser, S. J. Ortho-tolidine as a Reagent for the Colorimetric Estimation of Small Quantities of Free Chlorine. Ind. Eng. Chem., **5:** 915, 1030 (1913).
16. Griffin, A. E. and Chamberlin, N. S Some Chemical Aspects of Break-Point Chlorination. J.N.E.W.W.A., **55:** 371 (1941).
17. Calvert, C. K. *Private Communication.*

Modern Trends in Pumping Station Equipment

By Norman G. McDonald

PUMPING station equipment should be reliable, of adequate capacity and economical in first cost and operation. The reliability of equipment in municipal water supplies is of prime importance, particularly where little or no high level storage is available. Continuity of the supply of water is essential; interruptions caused by the breakdown of equipment or its failure to function properly cannot be tolerated. The very simplicity of the centrifugal pump, if it is well designed and constructed, makes it about the most reliable of all types of pumping equipment. The equipment, however, should be adequate to meet the demands arising from any combination of operating conditions with one pump out of service.

Too often in the selection of pumping station equipment low first cost is mistaken for economy. Frequently, pumping equipment offered in the highest bids has been found to be the most economical as well as the most reliable. Saving dollars in original investments is a very important consideration but it must not be secured by sacrificing the proper functioning of the equipment.

Pumps

Centrifugal Pumps

The centrifugal pump has been developed along the lines of the water turbine, although its progress lagged behind for many years. In recent years, through laboratory research and increased experience, pump designs have been improved greatly, with the result that pumps can now be built with efficiencies equal to those of water turbines of similar sizes and specific speeds. The similarity of the centrifugal pump and the water turbine in basic design is well illustrated by the laboratory tests made on the pumps for Grand Coulee Dam. In this study, it was found that when the pumps were operated in reverse, as turbines, they had approximately the same efficiencies as when operated as pumps. In comparing the efficiencies of

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pumps and water turbines, however, it must be borne in mind that the largest pumps are small in comparison with the largest turbines.

Like water turbines recent pump installations indicate a trend toward the use of higher specific speeds for low heads. The specific speed of 2,500 in the formula $N_s = \frac{\text{rpm.}\sqrt{\text{gpm. (U.S.)}}}{H^{\frac{3}{4}}}$ is said to be the most efficient up to about 92 per cent. While the increase in the specific speed reduces the cost of the pumping equipment, it does require higher internal velocities; and, if carried too far, absolute pressures in some parts of the pump may be reduced below the vapor pressure of the water, resulting in cavitation, with its attendant noise, pitting and wear on the impellers. The lower the total head and suction lift, the higher the specific speed may be. Without special tests or experience with pumps of somewhat similar characteristics, however, the specific speed should not be allowed to exceed the limits recommended by the Hydraulic Institute. In fact, a safe margin should be allowed if quiet operation is essential.

Although a very simple looking machine, an efficient centrifugal pump is one of the most difficult to design and construct satisfactorily. New designs should be developed through careful research and experimentation. In the design of large pumps, models are frequently used to advantage. The experience of the manufacturer in building pumps of somewhat similar characteristics, however, is of great importance, because the exact conditions of operation cannot be duplicated and the pump may be noisier than the model and subject to cavitation through construction irregularities, higher velocities or lower absolute pressures.

The specific speed of a pump has a great influence upon its characteristics. The early centrifugal pumps were equipped with large diameter impellers in which the flow was radially outward, resulting in low rotative speeds. As the head generated by a pump depends mostly upon the peripheral speed of the impeller, it was found that, following turbine practice, higher rotative speeds could be used by reducing the impeller diameter and extending the blades into the eye of the impeller, thus causing some of the work to be done in a direction parallel to the shaft. This is known as the mixed flow or diagonal flow type.

Propeller Pumps

The propeller pump developed from the propulsion of ships rather than from the centrifugal pump. Three of these vertical "screw" type pumps were installed in Toronto in 1910 and are still operating satisfactorily. Two have capacities of 18 and one, 9 mgd.*, with a lift of 15 ft. The speed

* All values in gallons, except when specifically labeled (U.S.), refer to Imperial gallons (1 Imperial gallon = 1.2 U.S. gallons).

is 725 rpm., so that specific speed is nearly 12,000 gal. (U.S.), but, as the propellers are submerged, little pitting has resulted. Larger pumps of this type were installed in New Orleans at the beginning of the century, and in 1906 propeller pumps with capacities of 666 cfs., operating with a lift of 6 to 16 ft., were installed in Chicago. From these early pumps the propeller turbine was developed in 1915; and since that time the propeller pump has been greatly improved so that its efficiency is almost as high as that of the centrifugal type.

Present practice is to use the low specific speed radial flow impellers for high heads and the propeller type axial flow pump, with its high specific speed, for very low heads and large capacities. Between these two types there is a mixed or diagonal flow pump used for intermediate conditions.

In the propeller type of pump the propeller blades can be attached to the hub in such a way that they can be rotated to any desired angle, in which way the capacity of the pump can be changed to provide for seasonal variations in demand. The efficiency of the pump from about half to full capacity can in this way be maintained within about 5 per cent of the highest efficiency. A few larger pumps have been installed with propeller blades which are adjustable from outside the casing when the pump is stopped and others of large capacity have blades which are adjustable (in the same manner as in the Kaplan turbine) while the pump is running. The provision for blade adjustment materially increases the cost of the pump, but the efficiency, flexibility and ease of automatic or remote control it affords, makes it very attractive for large, low lift installations. One unit, of full plant capacity, can thus be used efficiently for all pumping rates.

Specific Speed

Although the use of a higher specific speed for a pumping unit reduces the cost, it does change the characteristics. In some cases, in which the head discharge conditions vary, this may be a distinct disadvantage in that the head discharge curve is generally steeper, the top efficiency is maintained over a narrower range and the power required at zero discharge is greater. For a low specific speed pump, the horsepower required at shutoff may be only one-third of the power required at full capacity, whereas with a high specific speed pump, the power required at shutoff may be as much as three times that required when operating at normal capacity.

Figure 1 shows the head and power curves of four typical pumps of different specific speeds. It is seen that, for the high specific speed type, the discharge gate valve should be open before the pump is started or serious overloads will result. Where the head and discharge conditions vary greatly, the propeller type of pump with fixed blades is not suitable.

In such cases, either the propeller type with adjustable blades, a lower specific speed centrifugal pump or a variable speed drive should be used.

Head Discharge and Suction Lift

In the selection of a pump, the head discharge conditions and the suction lift should be given consideration. In pumping direct to a distribution system, it is desirable that the head discharge curve be as flat as possible,

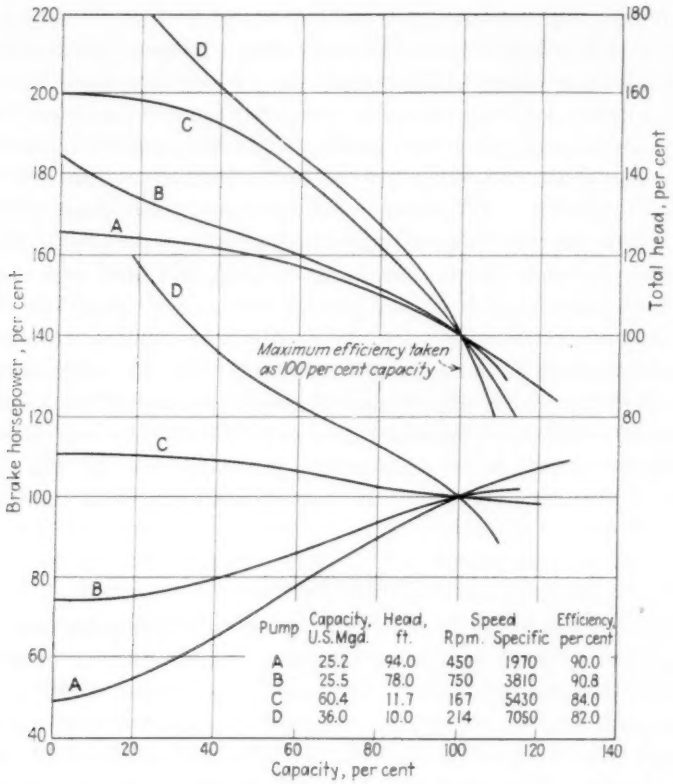

FIG. 1. Head and Power Characteristic Curves of Pumps of Various Specific Speeds

so that variations in pressure in the mains may be kept within reasonable limits. In fact, a rising head discharge curve would be advantageous, as it tends to offset friction losses in the mains and maintain a more uniform pressure in the distribution system. Although centrifugal fans frequently have this characteristic, the author does not know of any pumps so developed. If the water is being pumped to a storage reservoir, it is usually

desirable to have a steep head curve so that the pump will deliver as nearly as possible its full capacity with variations in the pumping head. For such a condition, the non-overloading type of impeller can easily be used, as the head may be reduced at a greater rate than the discharge increases, i.e., the tangent to the head discharge curve on percentage co-ordinates is steeper than 45 deg.

Many of the older pumps had a cylindrical type of casing with single suction impellers, on which, following the turbine practice, guide vanes were installed in the casing outside the impeller. It was found, however, that the spiral casing improved the operation of the pump and that the guide vanes, which are necessary for water turbines, are not required and are not now used in centrifugal pumps on this continent.

To reduce the end-thrust, double suction impellers were developed. These are really two single suction impellers placed back to back, operating in parallel, but with no separating wall. The double suction impeller is used almost exclusively for single stage pumps, except in very small sizes, and for high specific speeds. They are also used to a great extent for multi-stage pumps of two or three stages. Where a large number of stages are required, however, the passages through the pump become quite complicated. For two-stage pumps has been developed the double suction principle, under which two impellers are placed back to back, one for each stage, thus to a great extent balancing the end-thrust. Very few pumps require more than two stages where 60-cycle electric power is available, since a high head per stage can be generated.

Although theoretically correct principles of design must be used, the impellers and casings must be developed from actual experiments and tests. This is, of course, entirely in the hands of pump manufacturers.

Wearing Rings

The use of the proper type of wearing rings between the impeller and the casing is important, particularly in the maintenance of efficiency over a period of years. Wearing rings should be located where the diameter is small, to reduce the area subject to leakage. The radial clearance should be reasonably close, but there is a practical minimum limit to this, since, in spite of stiff shafts, some bending often takes place. If the clearance is too small, the rings will contact during operation and either seize or wear. This is particularly true with horizontal pumps in which the shaft must span a considerable distance between bearings and, in addition to carrying the weight of the impeller and sleeves, must resist some thrust resulting from the reaction of the water in the casing. This thrust may, under certain conditions, such as during the starting operation, be greater

than most engineers realize. In the 22-mgd. pumps installed at Calgary, Alta., the ring clearance was 10 mills. This was found quite satisfactory for the vertical turbine-driven units, but the horizontal pumps, driven by electric motors with full-voltage starting, could be operated only a few minutes before the power input began to increase. When the pump was shut down it was found that the rings had seized. The clearance in these rings was then increased to 13 mills and no further difficulty was experienced. Again in the 25-mgd. high lift pump recently installed at the Toronto Victoria Park Pumping Station, the ring clearance had to be increased to 12 mills.

The type of ring has a considerable influence upon the amount of leakage and, therefore, upon the efficiency of the pump. With new pumps, the leakage through the various types of rings does not vary a great deal;

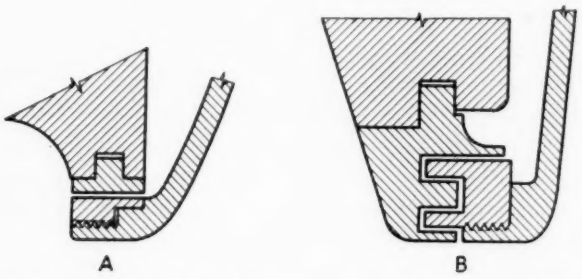

FIG. 2. Centrifugal Pump Wearing Rings—Plain (*A*) and Labyrinth (*B*) Types

but, as the clearance between the rings increases due to wear, the leakage may cause a serious drop in capacity, as well as in efficiency. Ring leakage lowers the head discharge curve; and, if the curve is of the flat type, the reduction in capacity when delivering against a constant head, such as to a reservoir, may be several times the amount of the actual leakage. Excessive wear on the rings may be caused by misalignment, an unbalanced impeller, a bent shaft or often by a shaft that is so flexible that the rings contact under certain operating conditions.

The simplest form of wearing ring unit is the plain cylindrical type, one being placed on the impeller and the other on the casing. These are often referred to as flat or straight rings because the passage on the axial section is straight, as indicated in Fig. 2A. With this type of ring, the clearance is kept to a minimum, but it may easily be seen that, as the clearance increases from wear, the leakage through such a passage becomes considerable. It is also apparent that, if one or more sharp bends are placed in the passage, the leakage will be reduced greatly; and, with a

liberal clearance between the rings, the amount of leakage can be kept reasonably low by the insertion of several such bends. Figure 2B shows a cross-section of rings of the double labyrinth type. These rings provide a tortuous passage in which there are seven sharp right-angle bends. Experience with pumps equipped with these rings indicates that they will give many years of service before leakage becomes noticeable. Rings on all pumps used for continuous service should be of the labyrinth type, containing at least two or three bends.

The material most suitable for wearing rings will depend to some extent upon the quality of the water. Bronze has been used extensively. In recent years, several centrifugal pumps equipped with "ni-resist" iron casing rings and stainless steel impeller rings have given good service. If the water contains fine sand or grit it may be advantageous to provide grooved rings and to flush them continuously with clean water at a pressure above that of the pump.

Other Features

Bearings

The bearings used on the modern pump are mostly of the ball type, for the small units, and of the ring-oiled sleeve type, for the large units. Some engineers still prefer the sleeve type of bearing because it is quiet in operation and the lubrication is visible. Probably a great amount of the trouble which has been experienced with the ball type of bearing could have been eliminated had larger bearings been used.

Glands

Where the shaft goes through the casing, a gland or water seal must be provided to prevent the inflow of air, where there is a suction lift, or to prevent the leakage of water, where the inlet is under pressure. Within the gland the shaft should be covered with a renewable sleeve, as some wear always takes place in this part of the pump. In some cases where the packing has been kept too tight or where sealing water has contained grit or has been corrosive, the wear has been excessive.

Some difficulty has been experienced with pump glands which are used intermittently or which stand idle for long periods. Frequently, during these idle periods, the packing becomes dry, so that when the pump is started the glands leak. The operator then tightens the gland nuts to reduce the leakage to a reasonable amount; and, when the packing again swells by the absorption of water, the gland becomes too tight, exerts a high pressure and causes wear on the sleeves. For pumps which operate

with suction lift and which are used intermittently or are primed by vacuum, water should be applied to the glands continuously from an external source, thus enabling the operator to maintain them in good working condition.

Cavitation

Cavitation, which is the formation of cavities or voids in the water, is one of the common ills of centrifugal pumps. It may be caused by too high a specific speed or suction lift, by operation under conditions for which the pump was not designed (particularly at lower heads) or by faulty design, causing the water to pull away from the metal surfaces because the curves are too sharp for the water to follow at the high velocity in the pump. When conditions change, the cavity thus formed collapses and the water hits the surface a heavy blow. As this continues the surface becomes pitted and worn. Unfortunately, the crackling sound of cavitation can still be heard in many pumping stations; but there is a definite trend, as the problem is becoming better understood by pump designers, toward the building of pumps which are free from cavitation and noise during normal operation.

Fire Protection Supply

In many water works systems, fire protection demands make necessary raising the pressure above that required for domestic service; and, frequently, the same pumps are used for both conditions. The pumps may possibly be designed for the high head required for fire pressure, but operated, without change of speed, almost continuously at the lower domestic pressure. This results in low pump efficiency, high power costs, noisy operation and excessive wear on the impellers. If the pressure has to be raised during fires, it is more satisfactory to have two different pumps, so that both may be suitable for the conditions under which they operate. On the other hand, a booster pump may be used in conjunction with the domestic service pump to raise the pressure to the point desired by the fire department. For large municipalities it is considered better practice to maintain the regular service pressure and to use portable fire pumpers as required.

Pump Drives

The use of electric power has greatly increased during the past 30 years. In 1941 the amount of power generated in Canada was twice that in 1932 and four times that in 1923. At the present time an average of five million horsepower is being generated in Canada—practically all from water power, with its low labor and materials cost. The increase in the use of elec-

tricity has resulted in the reduction in rates to users, so that electric power can now be obtained in most localities at a lower cost than any other type of power.

In some districts where coal is cheap, pumps may be driven economically by steam turbines. A few localities are fortunate in having water power available for pump drives, while others find it economical to use diesel engines. Gasoline engines, due to the high cost of fuel, are rarely used for continuous duty in water works pumping stations, but are useful for standby purposes.

Electric Motors

The reliability of electric power has improved with the increase in its use, chiefly through the development of new and better electrical equipment. Under present conditions very few pumping stations experience power interruptions amounting to more than a few minutes at a time and on but few occasions during the year.

Motors

Electric motors have been materially reduced in cost through reduction of unnecessary weight and more accurate design. At the same time, the insulation has been improved and both the power factor and efficiency increased. The types have become more numerous, so that it is now possible to secure a motor suitable for any pumping load. Fortunately, the average centrifugal pump has a comparatively easy load to start and to carry and does not require any special design of motor. About 20 years ago, the low starting current type of squirrel-cage induction motor was developed. This has become very popular for pump drives because it can be started under full voltage, thus simplifying and reducing the cost of the control equipment. For small high speed pumps the squirrel-cage induction motor is the most reliable and economical, but, for large pumps and lower speeds, the efficiency and power factor of the induction motor decreases, so that the synchronous motor is more economical.

The wound rotor induction motor, with adjustable speed control, is useful where speed regulation is desired, such as for pumping direct to a distribution system. While the full speed efficiency and power factor of the wound rotor motor is the same as that for the squirrel-cage induction motor, both efficiency and power factor decrease rapidly with the reduction in speed. Nevertheless, where a pump must be operated for long periods at reduced capacity it is more economical to do so by means of a wound rotor motor than by the throttling of the discharge valve, unless the power factor is reduced to the extent that a penalty is imposed by the power company.

The synchronous type of motor is useful for power factor correction and has been improved materially in recent years. The early synchronous motors had to be started and brought up to speed by some such external machine as an induction motor. Now, however, induction windings are used to provide any starting or pull-in torque characteristics required for centrifugal pump drives. Standard motors can be used under average conditions; but, for pumps of high specific speeds, special motors with high pull-in torque characteristics must be used, because the power required at reduced discharge rates may be as great or even greater than at full capacity.

The synchronous motor is a constant speed machine, so that, where variable speed in a pump drive is required, a variable speed coupling, either electric or hydraulic, must be used as an alternative to the wound rotor induction motor. Variable speed couplings give excellent speed regulation, but are, unfortunately, quite costly. Their use is not often justified, except to avoid penalties for low power factor. The efficiency of the hydraulic coupling at full load and full speed is about 98 per cent and, like that of the wound rotor motor, decreases directly with the speed.

For small municipal water supplies, where there is a large seasonal variation, the squirrel-cage induction motor with full-voltage starting, equipped with adjustable pitch sheaves and V belts, constitutes a very economical, efficient and suitable drive, particularly in areas served with 25-cycle electric power, as the pump speed may be higher than that of a two-pole motor.

Controls

Progress in control equipment for motors has been more marked than in the motors themselves. For the smaller full-voltage starting induction motors, the simple magnetic starter, with overload and under-voltage protection and operated by push button, is the most popular type of control. Where a pump is to be controlled automatically by pressure switch or time switch, or operated from a remote point, the magnetic starter is especially suitable, reliable and low in cost.

The control of synchronous motors is somewhat more involved, but, if arranged for full-voltage starting and automatic synchronizing, it is not unduly complicated. In large pumping stations, control equipment is usually located in a separate room. Most of the recent installations have been remote-controlled from a central panel. Protective devices for safeguarding both the equipment and operator have been improved greatly during recent years and, though such devices require a higher grade of workmanship for their maintenance, they have materially reduced the operating hazard.

The fully enclosed type of switch gear has been used in many recent installations. The Victoria Park Pumping Station at Toronto is equipped with gum-filled metal-clad switch gear located in a separate room and operated by push button control from the control room above. This type of switch gear offers the least operating hazard, but is considerably more expensive than other types.

Turbines

Steam Turbines

Steam turbines have had considerable use for driving centrifugal pumps. In some cases they are more economical than electric motors, having been used to advantage in the larger pumping systems for carrying peak loads in conjunction with electric motors. The usual electric contract is on the combined peak-load and kilowatthour basis. In such a contract, power cost per unit decreases as the load factor increases. In the Toronto area the cost of electric power is only 0.46 cents per kilowatt hour for 100 per cent load factor, but increases to 0.6 cents for 70 per cent load factor and to 0.9 cents, for 40 per cent load factor. The total cost of pumping may be reduced by operating the electric motors at nearly 100 per cent load factor and carrying the balance of the load with steam turbines, which need be operated only for short periods.

The efficiency of steam turbines has been increased materially, mainly through the use of high temperature superheated steam and higher operating pressures. Most steam turbines operate at speeds much higher than are suitable for centrifugal pumps, so that speed reducing gears must be used. The steam turbines at the John Street Pumping Station in Toronto operate at 3,600 rpm., herringbone gears reducing the speed to 600 rpm.

Water Turbines.

The water turbine is probably the most reliable drive for centrifugal pumps, but, unlike the steam turbine, its speed is usually lower than can be used efficiently for direct connection to the pump, so that speed increasing gears must be employed. An exception to this is the Calgary installation, shown in Fig. 3, in which the turbines operate under a head of 55 to 60 ft. and are direct-connected to vertical pumps having capacities of 22 mgd. against a head of 90 ft., operating at a speed of 450 rpm. These units are practically ideal in that they are absolutely noiseless, have excellent speed control and are very efficient over a wide operating range. In-place tests of the turbines by the salt titration method and of the pumps by Venturi meter showed an overall efficiency of nearly 80 per cent. These

turbines have now been in operation continuously for nine years and, in that time, no repairs except to a turbine steady bearing, have been required.

Vertical water turbines are used for driving pumps at Ottawa and Peter-

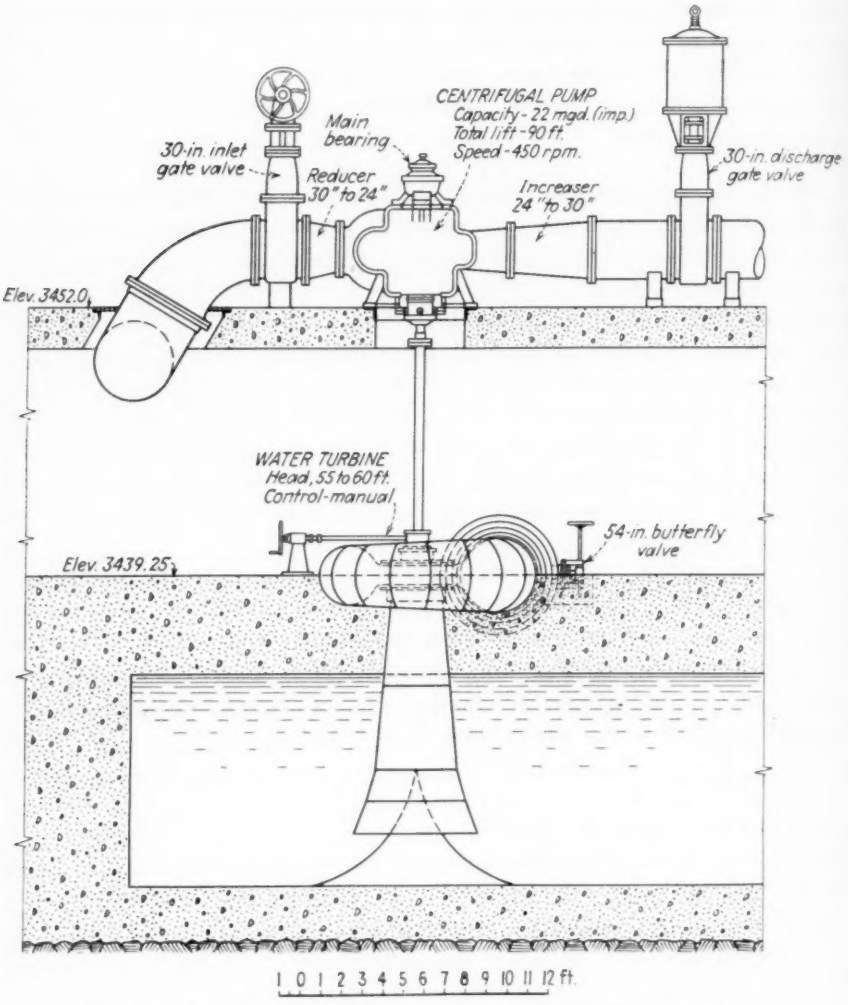

FIG. 3. Water-Turbine-Driven Centrifugal Pump, Calgary, Alta.

borough, Ont., but, due to low heads and resulting low operating speeds, right-angle beveled gears are used to increase the speed required for the horizontal pumps. These gears appear to be operating satisfactorily, although the former is not as quiet as desired.

Diesel Engines

Diesel engines are quite reliable and, in some cases, economical for pump drives. They are not, however, being used extensively, owing possibly to the fact that their speeds are much lower than required for direct connection to centrifugal pumps. An exception to this is the diesel-engine-driven pump installed at Ottawa in 1932. This pump has a capacity of 35 mgd. at 47.5 ft. head, direct-connected to a 420-hp. 6-cylinder 4-cycle diesel oil engine, operating at a speed of 375 rpm. Fuel consumption of engines of this type is about 0.40 lb. per brake horsepower hour. This unit was installed for standby service and is quite suitable for the low head conditions. For higher heads, the speed would have to be stepped up; and most engineers are somewhat reluctant to employ speed increasing gears on slow speed reciprocating engines, even when such engines are equipped with substantial flywheels. The inclusion of a hydraulic or electric coupling between the engine and the gear would cushion the pounding effect of the engine, but it does make a very expensive unit.

In the last few years diesel engines operating at much higher speeds have been developed, such as the General Motors diesel used for electric sets, but these are of comparatively low capacity. The author has not yet been able to secure a quotation on one of these engines equipped for pump drive.

Gasoline Engines

Gasoline engines operate at much higher speeds than diesels and are quite suitable for direct connection to centrifugal pumps of moderate heads. For low head pumps a reducing gear may be necessary to make it possible to operate the engine at an economical speed.

There has been a very definite improvement in gasoline engines in recent years. Gasoline itself has been greatly improved in quality, permitting the use of higher compression ratios, higher speeds and much greater power development, which, with better materials, has resulted in a reduction in weight and cost. Engines for motor cars, airplanes and boats are good examples of the trend in improved design, but the industrial engines equipped for pump drive do not appear to be greatly different from those available fifteen years ago.

The gasoline engine has not been developed in sizes comparable with the diesel engine. The largest engine available for pump drive develops about 585 hp. at 1,200 rpm. and, in Canada, costs about $31 per horsepower. Another large engine available for pump drive develops 340 hp. at 1,450 rpm., costing about $21 per horsepower. Several smaller engines are available at lower unit costs.

While the diesel engine requires 0.4 lb. of fuel oil per brake horsepower hour, the gasoline engine requires 0.65 lb. of gasoline per horsepower hour. Because of the high cost of fuel, the gasoline engine cannot economically be used for continuous duty. It is, however, particularly useful for standby service and intermittent use.

Piping

If the piping within the pumping station does not receive the same consideration as is given to the pumping units, which it frequently does not, the efficiency of the pumping station suffers. The size of piping, including valves and meters, should be worked out on the basis of economy and the total annual charges on the cost of the piping, including power losses, should be a minimum. Under normal pumping station conditions the velocity through a 12-in. pipe should be about 7 fps., but, with low power cost and low load factor or larger capacities, higher velocities may be economical. Lower velocities may be justified in the suction piping if it is necessary to maintain a low suction lift.

An elbow on the suction nozzle of a horizontal double suction pump should be vertical, so that the flow to each side of the impeller may be equalized. If the bend cannot be vertical, a special elbow with guide vane should be used, together with a piece of straight pipe between the elbow and suction nozzle.

Possibly the greatest common error made in the discharge piping of pumps is the use of an increasing bend directly on the discharge nozzle, in which velocities range from about 12 to 25 fps., averaging about 15 fps. Such a bend, increasing from 8 in. to 12 in., carrying 2,000 gpm. would have a velocity head difference of 2.93 ft. While the author has not been able to obtain definite, reliable test data, available information indicates that there is no recovery of head in an elbow of this kind. Based on Toronto power costs and a load factor of 70 per cent, the bend, costing only $20, may cause a loss of over $1,000 over a period of fifteen years. If a bend must be installed on the discharge nozzle of a pump it should be of constant diameter and then followed by a straight increaser. It is better practice, however, to install the increaser directly on the discharge nozzle, so that the bend, when used, will have a low velocity and, consequently, a low loss of head. By means of an increaser with a length ten to eleven times the difference in diameter, about 90 per cent of the velocity head in the nozzle can be recovered.

Bends in pipe lines are usually required within the pumping station; but, in installations such as the Ottawa low lift pumping station and the Calgary pumping station, the number of bends has been kept to a minimum through the use of horizontal discharge piping directly from the pumps.

Although very little research has been done on the losses through bends of expanding diameter, considerable information is available on the flow of water through bends of constant diameter. While bends of very short radius have rather high hydraulic losses, because of the abrupt change of direction, those of abnormally long radius are not necessarily superior, because the hydraulic disturbance, though less intense, is continued over a greater length of pipe. The experiments carried out by Yarnell* show that, for a 6-in. diameter bend with an $8\frac{1}{4}$ in. radius, made of celluloid, the hydraulic loss was 0.15 velocity head, excluding pipe friction. This bend was particularly smooth and, for the ordinary cast-iron bend, the coefficient would probably not be less than 0.20. The bend tested was of nearly standard short radius dimensions and, possibly, the standard long radius bend would have a slightly lower coefficient.

Loss of head coefficients of bends vary approximately as the square root of the angle, so that the coefficient of a 45-deg. bend is approximately three-quarters that of a 90-deg. bend. Losses in tees and crosses are high and, where these fittings are required, velocities should be kept low.

Valves

Check Valves

During the past 20 years a good deal of study has been given to the valves required on centrifugal pumps. Considerable difficulty has been experienced with check valves through the wearing of the hinges and from slamming action, with its resulting high surge pressures. The loss of head through such valves has been known to be high, particularly on the larger sizes. The continuous flow of water makes the position of the disc unstable, resulting in an oscillating movement and consequent wear on the hinges. A check should not be placed immediately downstream from a bend, as the disturbed flow will increase the disc movement. Some of the check valves have the steel hinge pin placed in a recess in the cast-iron valve body, so that, for continuous operation, wear takes place very rapidly. Check valves of this type should be provided with renewable bushings in the valve body, to reduce the wear and to permit quick repair.

Tilting Disc Valves

For the past ten years a tilting disc valve has been available in Canada. Although this valve, in the author's opinion, is not superior in principle to the standard check valve from the standpoint of slamming, it has a distinctly lower loss of head. The fluctuating or oscillating movement of the disc is prevented by a stop when the disc is in the wide open position,

* YARNELL, DAVID L. Flow of Water Through 6-Inch Pipe Bends. U.S. Dept. of Agric. Technical Bul. No. 577 (Oct. 1937).

the hinges are well constructed and provision is made for lubrication, resulting in much lower maintenance cost. This valve may be used in either the horizontal or vertical position; but, in order that the disc may be maintained in the full open position against the stop and that the loss of head may be low, the size should be carefully selected. The velocity through a 12-in. valve should not be less than about 7 fps.; but, as the loss of head is only about 0.3 of the velocity head, losses resulting from velocities up to 10 fps. should not be excessive. Based on Toronto power costs, with 70 per cent load factor, a 12-in. tilting disc valve is the most economical size for 2,000 gpm. and is considerably more economical than an ordinary swing check valve, which is lower in price but has a much greater hydraulic loss. The addition of oil-filled dash pots on tilting disc check valves, to cushion the closure and prevent slamming, has improved their operation.

Other Types

Foot Valves

Foot valves are usually inaccessible and cause unnecessary hydraulic losses. There is a definite trend toward their elimination and the substitution of the vacuum priming of the pumps, either by means of a vacuum pump or, for smaller units, the water eductor.

Gate Valves

Gate valves have changed very little, but recent installations indicate that for all except the smaller pumps these valves are operated by hydraulic cylinders.

Combination Valves

Valves performing the combined duty of stop and check have come into use during recent years. A few valves of the piston type have been installed, but by far the greater number have been of the rotating plug type, such as the cone valve. The latter valve has the best closure characteristics and the lowest loss of head of all valves available for pump discharge lines. It is, however, somewhat expensive; and some engineers feel that, for check valve duty on long pipe lines, the type of control equipment required for its operation makes it less reliable than a good quality check valve. For regulating duty, particularly where frequent operation is necessary, the cone valve is particularly suitable.

Meters

The metering of the electric power input to the pumping station is essential for the payment of power, but the metering of the water delivered by the pumps is useful information and should be provided even in small

stations. In the larger stations the electric input and the water output of each pumping unit should be metered.

Practically all pumping station meters for water are of the flowmeter type, in which a differential is produced and continuously indicated or recorded in corresponding units of measurement. This differential is approximately the difference in velocity heads in the pipe itself and in a section constricted to increase the velocity. The speeding up of the water is easily accomplished, but its deceleration to the original velocity can be accomplished only by a sacrifice of pressure. Of the three commonly used differential producers, the orifice causes the greatest loss of pressure and the long Venturi tube, the least.

Assuming a throat diameter of one-half that of the pipe, the loss in an orifice is nearly 75 per cent of the differential, while in a long Venturi tube, the loss may be as low as 10 per cent. Between these are the simple flow nozzle, the flow nozzle with recovery cone and the shorter Venturi tubes. Because of its high loss of head, the orifice can rarely be used economically for full-time operation in any pumping systems, but may be useful for measuring short period flows such as the discharge from fire pumps. The flow nozzles are somewhat better; but, for continuous duty, the standard Venturi tube, with a length of sixteen to seventeen times the difference in diameter of pipe and throat, is practically always the most satisfactory and economical.

The discharge coefficients of Venturi tubes are slightly higher for larger sizes and greater throat velocities and vary somewhat with the shape of throat, but not with the angle of divergence of the discharge cones. Variation of coefficient with throat diameter and velocity is shown in Fig. 4*. These coefficients are for tubes with upstream cones of 21 deg. total angle of convergence and rounded throats. The 48 by 30-in. "Simplex" Venturi tubes, installed at Calgary in 1932, were carefully calibrated by displacement tests and had a coefficient of 98.25 for a throat velocity of 8.3 fps. This is somewhat lower than indicated by the above curves, but the difference may be explained by the shape of throat.

Instruments for interpreting the differentials and indicating and recording the flows have, with few exceptions, one part in common—a float, operating on mercury. As the flow varies with the square root of the differential, a device is required to make the movement of the indicator directly proportional to the flow. This may be done by means of a cam, a specially shaped differential float, a shaped mercury well or by linkage. The cam has an advantage in that it may be altered to suit tubes of various

* *Report of Special Research Committee on Fluid Meters.* Am. Soc. Mech. Engrs., New York (4th ed. 1937). p. 101.

sizes and coefficients. A recent instrument includes, in addition to the cam, a mercury well which is specially shaped to produce more accurate readings at low differentials.

The meter tubes have not been changed materially in recent years, but there has been a trend toward the use of tubes with larger throats, resulting in lower differentials. This has been done to reduce the cost as well as the hydraulic losses. The recording of the lower differentials has been made possible through the development of more sensitive indicating equipment. It must be realized, however, that meters operating on low differentials are more susceptible to approach conditions and are subject to greater errors. Any type of flowmeter should be preceded by a straight length of pipe and, if accurate metering is to be obtained, the length of

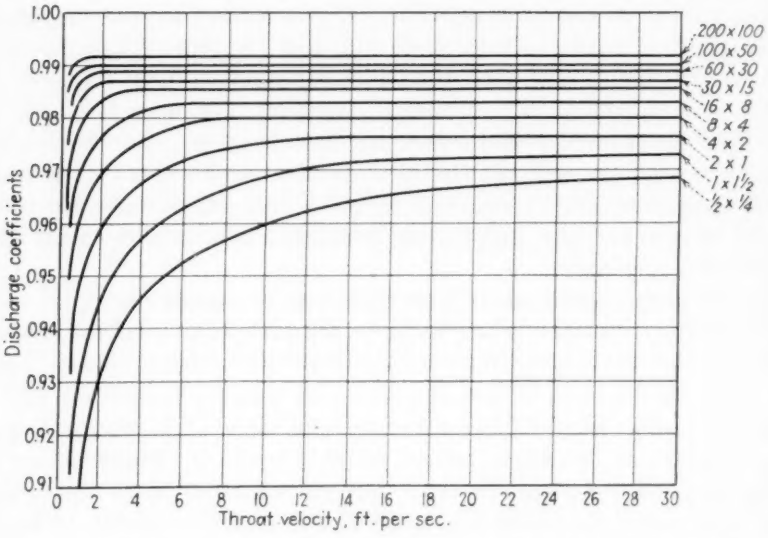

FIG. 4. Discharge Coefficients of Herschel's Design of Venturi Tubes

this pipe should not be less than 12 pipe diameters. A greater length should be used on meters operating on very low differentials. Errors as high as 10 per cent have been experienced where low differential tubes have been placed close to elbows. An error of 3 per cent at normal capacity was discovered in a tube located only 12 ft., nearly $3\frac{1}{2}$ pipe diameters downstream from a right-angle bend. Unless the approach conditions are reasonably free from disturbance, the accuracy of the differential should not be accepted until it has been checked by a displacement test, or some other accurate method, and the coefficient determined.

For metering, there has been a trend toward the use of lighter and

cheaper instruments containing less mercury and operating on lower differentials. In some of these models, such as the "Chronoflo," which was introduced about twelve years ago, the instrument is electrically operated on the impulse time duration principle, which reduces to a minimum the amount of work done by the float. This type of instrument is particularly useful for remote indication.

The selection of a meter should be made only after data regarding the location, flows and other factors are available; and the differential should not be reduced to the extent that the meter becomes unsatisfactory for the function which it is intended to perform.

Selection of Equipment

The selection of pumping station equipment has not always received the consideration it deserves. In many cases inefficient pumping equipment has been installed and in others the materials and construction were such that the efficiency dropped off rapidly with use. Frequently, the suction piping has been responsible for friction losses which have increased the suction lift to such an extent that the efficiency and capacity of the pump have suffered and its operation has become noisy.

With proper construction, an efficient pump will last longer than an inefficient one, because there is less energy to be dissipated within the pump to cause wear. In many cases, the equipment has been purchased on the price basis alone, with no evaluation of efficiency based on power cost. It is not uncommon to receive bids on pumps which would not be economical to accept, even though they were supplied and installed free of charge. Some pumping stations contain pumps in which sufficient power is wasted every two or three years to pay for new pumps of good quality. In one case, a few years ago, two pumps were replaced by new ones with the result that the power consumption was reduced 50 per cent.

Assuming, as an example, a typical electric-motor-driven centrifugal pump with a capacity of 2,000 gpm., with a total lift of 150 ft., operating with a 70-per cent load factor and a 75-per cent overall efficiency, cost of power being approximately 0.45 cents per horsepower hour of electrical energy consumed, if the equipment is paid for by 15-year debentures at $3\frac{1}{2}$ per cent, the present value of 1 per cent increase in efficiency is $710, although the pump, without motor, costs only $1,300. Such evaluation should be used in the selection of pumping station equipment, provided, of course, that the specifications require a quality of workmanship and material which will ensure reliability.

Owing to the standardization of motors, the selection is somewhat simplified. In the above example, if the frequency of the electric current is 60 cycles, the speed would be 1,750 to 1,800 rpm. The 125-hp. squirrel-

cage induction motor, with low starting current and magnetic starter and push button, control would cost approximately $1,300 delivered, while a synchronous motor with automatic push button control would cost approximately $2,700. The efficiency of the two motors would be approximately the same and the only reason for the extra expense of the synchronous motor would be the improved power factor which might or might not be of value to the system. If speed regulation is necessary a wound rotor motor with manual control may be purchased for approximately $2,400; or, if power factor is important, a hydraulic coupling can be added to either of the other two motors for an additional $2,300. For pumping stations supplied with 25-cycle power, the motor costs are about 50 per cent higher, and the synchronous motor is not available at speeds above 750 rpm., which is far too slow for operating this pump.

In general the trend in pumping station equipment is toward the use of more reliable and more efficient equipment throughout, resulting in fewer interruptions in the supply of water and reduced pumping costs.

ABSTRACTS OF WATER WORKS LITERATURE

Key, 31: 481(Mar. '39) indicates volume 31, page 481, issue dated March 1939. If the publication is paged by issues, **31:** 3: 481, (Mar. '39) indicates volume 31, number 3, page 481. Initials following an abstract indicate reproduction, by permission, from periodicals as follows: *B.H.—Bulletin of Hygiene (British); C.A.—Chemical Abstracts; P.H.E.A.—Public Health Engineering Abstracts; W.P.R.—Water Pollution Research (British); I.M.—Institute of Metals (British).*

WARTIME WATERWORKS PROBLEMS

Wartime Economy and Operation of Water Works. E. G. B. GLEDHILL AND A. W. H. MCCANLIS. Wtr. & Wtr. Eng. (Br.) **44:** 48 (Mar. '42). All water undertakings will have experienced restriction in supply of materials and labor as consequence of war effort. Experience, ingenuity and technical knowledge of management must be brought to bear on ways and means for improving eff. of operation by use of substitute materials, adaptation of used materials, etc. Question of cost not considered where purity of water concerned. Dealing with steam plant, boiler house place where best results can be obtained. Factors are fuel, feed water control, scale formation, blowdown, combustion, leakage of cold air into flues, short-circuiting of flue gases, faulty dampers and insulation, etc. Essential to maint. boilers and economizers free from scale. Recovery of some heat in blowdown may be done by passing it through coiled pipe immersed in feed tank or hot well. Prime movers work most efficiently at or near full load. Ability to vary speed of pumps useful. Water levels of wells or boreholes may be different; hence, wells with highest pumping water levels should be used as much as possible. Steam or elec. plant should be used (rather than diesel), since coal source of power for both while fuel oil must be imported and takes up shipping space. Of three types steam, elec. and diesel, latter most affected by proper plant maint. Pumping station staff may run plant inefficiently either in ignorance or in following path of least resistance. Sutton Co. under statutory obligation to supply water with hardness not exceeding 9 gpg. After being softened, water stabilized. Formerly obtained by injection of CO_2, but at one works carbonation has been displaced in favor of sodium hexametaphosphate. Most important item under distribution is waste of water. Waste may be divided into two parts, that which takes place in premises and that which occurs in mains. Sounding of mains at night under blackout conditions difficult and dangerous, but cannot well be done by day. Services can quite easily be tested by day. To use min. amt. of gasoline, trucks must be kept in good repair. Tires next most important item. Of replacement tires, during past 5 yr. only 25% have been new. Remainder retreaded. Guaranteed mileage given for retreads, figure varying from 15,000 to 20,000 mi. Another source of waste aggravated by black-out conditions is lighting, generally elec. Consideration should be given to movable shutters in order to take advantage of daylight. In lab. many solns. now made up from raw materials. Chief contribution of offices is economy in use of paper; and in draftsman's time by using reduced scales and by cutting out elaborate titles, etc. In reservoirs and grounds, scope limited. Maint. labor

may be limited and spare ground put to productive use. *Discussion. Ibid.* **44:** 113, 142 (May, June '42). H. J. F. GOURLEY: Fact that with possibly added stimulus of war more and yet more economic operation being sought leads to suggestion that in every undertaking same close scrutiny on operation and management should become watchword. N. A. F. ROWNTREE: While agreeing that unlimited availability of domestic water supply important aid to public health, this no excuse for abuse of privilege. Should be made offense for garden hose to be used for watering land not used for cultivation of foodstuffs. Large or rapidly developing munitions works capable of wasting huge quants. of water. Cases known of considerable waste on private works fire supplies which are usually unmetered. Military camps sometimes scenes of water wastage. Seems unfortunate that in wartime water undertakings should be compelled to soften all water they supply. Water softener can quite easily be operated by layman. F. K. SINCLAIR. Not clear why recommended that total solid content of boiler water should be maintd. near max. permissible concn. Such practice would seem to invite risk of exceeding limit while having no apparent advantage over working at lower value. Continuous blowdown generally preferable to intermittent operation. Writer cannot agree with recommendation that feed tanks should be as small as possible. Trouble arising with feed pumps due to feed water of too high temp. insufficiently stressed in paper. Reference to merits of speed control of slip ring induction motors driving centrifugal pumps by use of rotor control resistance fully indorsed. Improvement of power factor does not affect purse of power consumer, but from national economy point of view it is of importance. Obvious remedy for different pumping levels in wells and boreholes situated at same site would appear to be to connect whole system with adits. Not uncommon source of wasteful operation is custom of pumping over standpipe with object of maintg. sufficient head to supply small no. of properties on high ground. In such cases, often possible to zone off system. Authors mention use of softened water for lime slaking at works of Sutton Co. At Bushey works of Colne Valley Water Co., anals. made of sludge from slaking troughs disclosed high percentage of calcium hydroxide. After pulverization, large proportion of sludge capable of soln., with resulting economy in lime consumption. In referring to complete suspension of waste metering, preferable to operate a waste meter system to limited extent, having regard to wartime requirements, and so to be able to locate and deal promptly with proportion of waste, rather than to abandon leakage to fortuitous detection. Authors method of measuring reservoir level fall, as expedient for locating waste, appears to be useless and in no way a substitute for waste meter system.—*H. E. Babbitt.*

Protective and Remedial Measures for Sanitary and Public Health Engineering Services. *Second Progress Rept. of the San. and Public Health Eng. Div. of the National Com. of The Society on Civilian Protection in Wartime.* Proc. A.S.C.E. **68:** 951, 1013 (June '42). One of most interesting and well conceived organizations for civilian protection developed in Chicago. Plan arranged in series of reports, each dealing with hypothetical, but specific, emergency problem, such as repair of water mains, pumping stations, sewers, airport, bridges. Water Pipe Extension Div. has experienced breaks in water mains including repair of six breaks in large mains. Report describes in detail procedure to be followed in handling these breaks, including timetable and personnel [see Jour. A.W.W.A. **34:** 1210 ('42)]. On April 21, actual practice mobilization of personnel, equip. and materials for hypothetical breaks. Relatively large munic. utility dist. employing 84 guards at a monthly cost of about $15,000 to protect dams, reservoirs, aqueducts, water treatment plants and pumping stations. Midwest industrial city has made substantial progress in providing for civilian protection. Some $2,000,000 made available for constr. and project estd. at $1,500,000 under consideration for addnl. capac. and

stand-by equip. at water pumping stations. Considerable being done in communities adjacent to New York City. West coast city has under way project, estd. at cost of $445,000 for reinforcement of distr. system including cross-connections and valves. Mutual aid plans for maint. of water supply service have been developed in a number of states [see Jour. A.W.W.A. **34:** 189, 1173 ('42)]. Ind. committee has issued some very good bulletins. Memo dated Jan. 5, '42, from Fla. Bureau of San. Eng. includes many topics. Under the Ga. emergency protection program, State Dept. of Health has acquired chlorinating equip. and portable water lab. Data prepared by N.Y. State Office of Civilian Protection through Div. of Water Main Emergency Repairs. Particular attention called to importance in field of public health eng. of general sanitation problems relating to public comfort stations, milk supplies, rooming houses, and restaurants. *Discussion.* JAMES H. LEVAN: Insufficient stress upon making available emergency or alternate supply. In two instances stated that mobile filter units mounted on trucks obtainable, that will draw water from wherever it is available. Most smaller cities never will have such equip. In emergency, potable water distributed by tank trucks will furnish drinking water and will be accepted readily. CLARK GARDNER: True that fire-fighting equip. or portable gasoline engines could be located near lakes or rivers and water pumped through fire hydrants into distr. system. Fire dept. would be operating under serious handicap if equip. withdrawn to supply water from lakes or rivers to pump into distr. system. Provision of auxiliary supplies through driven wells in underground stations appears more practicable for several reasons. From standpoint of providing adequate protection to existing wells, pumping station bldg. reservoir and valve vault, useless to protect any single unit without installing protective devices to safeguard all units. Writer recommends use of auxiliary supply through driven wells. MICHAEL J. BLEW: Greatest danger from sabotage of water systems interruptions to service caused by physical damage willfully perpetrated against water works structures, of which intakes, dams, storage tanks, pumping equip. and valves generally most vulnerable. Much written concerning sabotage with chem. agents and pathogenic bacteria. Any chem. agent introduced into water system with intent to interfere with normal operation must be highly toxic in low concns. Large quantities must be used to be effective. Use of bacteria always possibility but their use on large scale thought to be doubtful. All munic. and military water supplies should maint. const. residual of free chlorine throughout system. Admission of chems. or bacteria to well-water supplies generally would be more difficult than for plants utilizing surface water. GILBERT H. DUNSTAN: Some kind of card briefly outlining proper emergency procedure could be given to each customer. Card should be hung in kitchen or other convenient place and all members of family should be familiar with it. Since iodine often found in homes for use in first aid, attention should be called to its use as water disinfectant. 10 drops of mild antiseptic (2%) soln., or 3 drops of 7% tincture of iodine, may be mixed with quart of water by stirring; then let soln. stand for ½ hr.—*H. E. Babbitt.*

Water Supply for Armies. F. F. LONGLEY. Military Eng. **33:** 467 (Oct. '41) (*see also* Jour. A.W.W.A. **34:** 11 ('42)). Adequate and safe supply vital for well-being of troops. Because dangerous poln. common in natural waters of France, provision for wholesale water treatment had to be met by AEF's Water Supply Service during World War. 26th Engrs. organized for purpose by selecting trained personnel who would be useful in water works program. Although originally designed to water supply needs of one field army, regiment divided among the 3 field armies of AEF. Collaboration of various other engr. units necessary to provide enough men for effective work. French Army water supply service gave much help. Today Army has advantage of AEF's experience in water supply and very complete and detailed reports made at end of opera-

tions. Tables of organization made for "Engr. Battalion, Water Supply." Intended to serve field army and will serve as flexible nucleus for whatever water supply work required. Divisions mobile and may become even more so; therefore should not be burdened with development of water supply. Corps less mobile, but sudden change in jurisdiction would result in transfer of water supply personnel with difficulty if this were Corps function. Logical to place responsibility and authority for water supply development in hands of engrs. attached to Army. Because Med. Dept. always has had responsibility of assuring that water supplies are safe for troops to drink, necessary to have respective duties of it and Corps of Engrs. carefully defined. Latter would make adequate quants. available at convenient points in as pure state as practicable, and former would attend to such subsequent disinfection treatment as required. Because of great difficulty of obtaining procurement of proper materials under wartime conditions, successful water supply officer is one who can build required facilities to conform to operations program, build them rapidly and with materials available. Today, easily portable type of treatment plant for troops developed. Consists of 40-gal. pump, hypochlorite treatment apparatus, all mounted on light pipe frame. Few of these units will supply needs of many men and animals.—*P.H.E.A.*

Sanitation in the Field in the United States Army. SAMUEL A. GOLDBLITH. **34:** 86 (Feb. '42). Offhand, military eng. may not seem closely related to san. science; nevertheless, a major job of military engr. is that of water supply and of sewage and other waste disposal in theater of operations. Advances in sanitation plus other advances in preventive medicine caused death rate due to disease to be much lower in World War than in any previous wars. Refuse and waste disposal in the field, like every other problem there, dealt with locally available materials and time limit. In World War, theory dispelled that troops in field could depend on country for water supply. In field, water supply, in addn. to being pure and adequate, must be flexible. Each field army has an Engr. Water Supply Battalion, in addn. to one being assigned to its general headquarters reserve. It has 9 mobile purif. units and each of 3 companies has 36 water tank trucks. At present each unit produces about 4,000 gal. per hr. of filtered and chlorinated water. Distr. effected by Lyster bag, distributed at rate of one per 100 men. Can be used when necessary for water sterilization. Hypochlorite or iodine can be used as disinfectant. Distr. of temporary water supply can be effected by surface or subsurface pipes or by company water carts. Following are estimates of water needs: permanent camps, 50 to 75 gpd. per person; temporary camps, 25 to 35 gpd. per person; bivouac or marching, 2 gpd. and 10 gpd. per animal; combat, 1 to 2 qt. per day and 3 to 5 gpd. per animal. For temporary camp, san. survey of source, method of purif., transportation and distr. made. For fixed installation, complete and detailed survey made. This reconnaissance is function of Corps of Engrs. and Med. Dept.—*P.H.E.A.*

Operation of Water Supply Equipment. THOMAS P. BROWNE II. Military Eng. **33:** 568 (Dec. '41). In connection with training of enlisted men to operate mobile and portable purif. plants, use of detailed log of operation found of extreme value. Sedimentation following addn. of alum coagulant found to increase length of filter run between filter washings as much as 8 times. Canvas basins can be used for settling, but before pumping settled water through filter, basin should be desludged by using quick opening valves furnished in water-supply set. To assist operator in detg. proper pH range for best coagulation, coagulation set similar to block comparator that has been devised is shown. Device to distribute raw water in portable filter unit shown. Tools needed by portable unit as well as mobile unit should be equipped with pick, axe and shovel to set up filter-unit equipment. Believed that U.S. Geol. Survey Turbidity Gage could be eliminated from mobile unit. Chest of tools and fittings illustrated.—*P.H.E.A.*

Engineer Board Notes. Water Supply Studies. ANON. Military Eng. **34:** 89 (Feb. '42). Because of military necessity, areas may be occupied which may have an abundant water supply or be waterless. Engrs. will have to find adequate water supplies and treat them to make them acceptable. Mobile purif. plants, canvas storage tanks and accessories for developing surface supplies available and very successful during recent maneuvers. Under other conditions might have been found more difficult to operate. "Water treatment necessities conditioned by peculiarities of water in particular place where water must be secured. Adaptation of treatment procedures must be initiated with some notion of needs of moment." Canvas bags or tarpaulin-lined excavations make excellent sedimentation basins. Coagulation of raw water with alum and soda ash at a pH of about 7.0 is usual practice. Will vary with water of different alky., etc., and a few milk bottles can be put to good use for preliminary trials. Nothing will substitute use of judgment. New illuminated comparator can be used to det. pH (or free chlorine content of treated water by using another color disc) even under blackout conditions. Where surface waters not available in area, will be necessary to find ground water. (Possibly water may have to be hauled in.) Engr. Board has tests under way on drive-point well equipment. Rotary well-rig adapted to Army needs. Cable-tool, or percussion well-rig, can be used where there are cavernous limestones. Time may not permit lengthy development of well to eliminate sand and grit. Here air lift pump and smaller diameter well casing will permit immediate use of well. Later on, development of well may be completed when military situation will permit. Because of contamn. of well due to sinking, water will have to be treated by filtration and chlorination at first. Engr. Board has developed portable shower-bath unit. Pumps and heats water for operation of 8 shower-bath heads. "Allowing 3 min. per man, capable of bathing 160 men per hr." Unit is trailer-mounted.—*P.H.E.A.*

Notes on the Storage of Emergency Drinking Water Supplies. H. H. CRAWLEY. Wtr. & Wtr. Eng. (Br.) **44:** 80 (Apr. '42). Question how long water can be stored becomes important, first, because of labor, transportation and time involved in changing water and, second, from aspect of conserving water. Street tanks, of 500-gal. (Imp.) capac. each erected on sidewalks. Intended to afford immediate supply until emergency water-carrying scheme brought into action. After erection, tanks filled with water chlorinated to 50 ppm., allowed to stand 1 hr., emptied and refilled from the mains. Subsequently, samples taken periodically for bact. examn. Matter of interest is periodic rise and fall in no. of colonies in plate counts on agar after 2 days at 37°C. All street tanks erected and filled by June '41 and after 3 mo. storage, bact. samples from all were class 1. Decided that, unless adverse samples occur sooner, water in tanks shall be changed every 3 mo. Air raid shelter containers galvanized-iron with 3-, 5- or 8-gal. (Imp.) capac. Bact. studies showed water good after 3 mo. storage, but routine changing of water after 2 mo. instituted. Rest-center tanks of ordinary rectangular galvanized-iron type vary from 100- to 1,000-gal. (Imp.) capac. Some tanks covered with wooden lids. These proved unsatisfactory; they warped and permitted poln. of water.—*H. E. Babbitt.*

Removal of Damaged Pipes. *Metropolitan Water Board Experiments With Explosives.* ANON. Wtr. & Wtr. Eng. (Br.) **44:** 132 (June '42). Removal of broken iron from crater slow and laborious process. Not always practicable to employ cranes in early stages, even if available. Alternative methods therefore sought by which damaged pipes could be quickly broken into easily handled pieces and board decided to expt. with use of explosives. Explosive used was "Gelamex No. 2," proprietary brand of gelignite obtainable in small plastic sticks about 4″ long and 1¼″ in diam. Firing performed electrically from hand-operated exploder about 50 yd. from trench. Expts. indicated removal of broken pipes would be greatly facilitated

by use of explosives. Sandbags prevented pieces of metal from flying out of trench. To test effect of explosions on nearby services 4″ c-i. pipes with lead joints laid on one side of "explosion" trench and 12″ earthenware pipes with cement joints on other side. 4″ pipes filled with water with internal pressure of 160′ while earthenware pipes also filled with water. At end of series of 6 explosions, 4″ pipe unaffected and held pressure. Earthenware pipes cracked in two places behind sockets and approx. opposite pipes on which largest charges of explosive used. In practice all possible steps should be taken to localize explosion. Main to be broken out should be emptied. Main should be cut on each side of crater prior to use of explosives. Three 4-oz. charges placed equidistant on circumferential line generally sufficient for pipes of 1″ thickness and over; 2- or 3-oz. charges suitable for thinner pipes. Charges should normally be placed on outside of pipe but small charges can be placed on inner surfaces if convenient. Explosive must be in close contact with pipe and held in position by pad of prepared moist clay pressed firmly around charge. Charges then covered with sandbags. Each 4-oz. charge should be covered with 10 to 12 sandbags which must be left free to move. Air space of at least 12″ should be left between sandbags and other pipes, ducts, etc. in proximity.—*H. E. Babbitt.*

The Emergency Sterilization of Water Mains. T. S. R. Winter. Wtr. & Wtr. Eng. (Br.) **44:** 101 (May '42). As consequence of widespread damage to mains, difficulty encountered after first heavy attack in Nov. '40 in operating mobile chlorinators which relied on pressure of water brought over long distances by hose pipes. Several methods of overcoming difficulty employed, including now common stirrup pump. Charts prepared giving capacs. of mains from 3″ to 36″, with quantities of chlorine, chloros and bleach required using concns. of 25, 50, and 100 ppm. To establish formula for coef. of dischg. applicable to any size of valve, careful tests under 42 different conditions carried out. Results suggest formula $V = 3.5\sqrt{H}$ (V = veloc. through valve opening, in fps.; H = sum of potential and kinetic heads lost through sluice valve). Areas of valve openings plotted against turns opened on sluice valves and rates of flow through sluice valves plotted on same diagram against areas of valve openings for 14 different pressure losses. When veloc. of approach great enough to represent foot or more pressure, such head has been deducted from value of H.—*H. E. Babbitt.*

Regulations Concerning Laboratory Equipment. J. S. Knowlson. Science. **95:** 652 (June 26, '42). WPB Div. of Industry Operations issued Limitation Order, L-144, June 12, '42, re mfr. and use of lab. equip. Due to critical shortage of scientific equip., university and other private labs. engaged in research unrelated to production of materials, or in other research not directly connected with war effort, cannot secure new lab. equip. unless particular use approved by Dir. of Industry Operations. Special provision made for handling equip. requests for uses not specifically permitted. Also order permits any lab. or other user to obtain parts and operation supplies for maint. of existing equip. and activities. Regulations affecting 600 mfrs., 3,000 labs., prohibit sale, delivery, renting or purchase of lab. equip. contg. Al, Cu, Fe, Mg, Mb, Ni, Ta, Ti, Sn, any alloy of these metals, steel, rubber, synthetic rubber, or non-cellulose base synthetic plastics. To buy or sell lab. equip. contg. above materials, duly authorized official of purchasing co. or lab. must certify that equip. will be used only for: (1) research on or anal. of materials; (2) research by or for govt. agencies or "Lend-Lease" countries; (3) training personnel of Army, Navy, other govt. depts. or "Lend-Lease" countries; (4) to extent necessary to replace essential existing equip. in pub. health, fed., state or local govt. labs.; (5) to extent necessary for repair parts and operating supplies for maint. of essential existing equip. and activities in labs; (6) for any use Dir. of Industry Operations dets. necessary and appropriate in pub. interest. Mfrs. will obtain materials by filing PD-25A applications under Production

Requirements Plan. Distributors, wholesalers, jobbers needing priority assistance, file PD-IX forms with WPB Distributors Branch. L-144 detailed.—*Ralph E. Noble.*

Research and Control. NORMAN J. HOWARD. Can. Engr.—Wtr. & Sew. **80:** 5:16 (May '42). During war of '14–18 price of filter alum in Canada increased to $60 per ton, due largely to shortage of H_2SO_4 and scarcity of freight cars. Now appears that present war will result in poorer quality of filter alum being available. (See A.W.W.A. Emergency Alternate Specifications for Sulfate of Alumina, Jour. A.W.W.A. **34:** 1073 ('42).) Due to increasing demand for Al, proposed to use high-grade bauxite for mfr. of metal and low-grade bauxite for mfr. of alum. Probable result will be reduction in alumina content from 17 to approx. 15%, increase in insol. matter content from 0.5 to 7.5%, and increase in Fe content. Many plants now using alum of high insol. content but others have reported difficulties due to deposits forming in feed equip. when such alum was employed. Latter plants may find it necessary to remodel their equip. to adapt it to use of lower grade coagulant. Reduction in alumina content will undoubtedly necessitate higher dosages and result in increased operation costs. Whether other chems. will be affected not known at present time. No curtailment in use of Cl_2 in sanitation expected, such use being considered essential to public health. Chlorine used in water and sewage treatment approximates only 5% of total now being mfrd.—*R. E. Thompson.*

The Full Utilization of Scientific Personnel. CHAS. H. BEHRE JR., HARRY GRUNDFEST AND ELVIN A. KABAT. Science **96:** 16 (July 3, '42). Patent failure to enlist volunteer services of hundreds of young scientists, as teachers or research workers, at this late date still not engaged in scientific work related to war. Many continue at peacetime and non-essential research though impatient for direction into more useful service. If exempt from service in armed forces because of positions or sex, feel themselves useless to war effort in spite, or *because*, of their special training. Seems proved especially true for all scientists outside fields of physics and math. Most biologists, geologists, large no. of chemists, retired or about to be retired scientists not being fully utilized. Should not older scientists, now in position of responsibility and command, more distinguished members of A.A.A.S., those engaged in formulating war plans of Natl. Acad. of Sciences and O.S.R.D. carefully consider this mobilization problem on scientific front? Morale among intellectual workers lowered when their wishes and efforts frustrated. If war to be prosecuted with utmost vigor, this personnel problem of outstanding importance to success in stern months ahead.—*Ralph E. Noble.*

ADMINISTRATION, PERSONNEL AND PUBLIC RELATIONS

A Survey Report. ANON. Pub. Mngmt. **23:** 259, 298 (Sept., Oct. '41). (*Parts I and II abstracted* Jour. A.W.W.A. **34:** 443 ('42).) *Ibid.* **23:** 334 (Nov. '41). *III. The Direction and Control of Activities.* City mgr. must delegate to subordinates most of administering but retains responsibility for eff. and min. cost. Must so organize that desired accomplishments will be effected. Among methods are: make dept. heads keep abreast of best developments, consider published methods of others, encourage initiative, analyze reports of dept. heads, commendation for good work, support dept. heads, encourage dept. heads to distribute their work, hold meetings to discuss problems. Oral directions preferable on minor routine matters; in non-routine matters, written orders desirable. Co-ordinating activities of all depts. require continuous attention; water dept. meets requirements of fire dept., etc. Mgr. should have broad vision, needs to visualize inter-relationships of all factors involved,

retain perspective, be a generalist. Must use various formal and informal methods to secure voluntary acceptance, by all, of administrative policies. *Ibid.* **23:** 363 (Dec. '41). *IV. Administrative Records and Reports.* City mgr. cannot function effectively, without reliable, up-to-the-minute information about deptl. activities, past, present and anticipated, concerning accomplishments and lack thereof. Almost all of 20 city mgrs. contacted require periodic reports. Mgr. can appraise eff. of admin. operations from submitted records and reports. Periodic reports from dept. heads needed so that mgr. can report back to depts. Explanation of this anomaly is that each deptl. report deals intensively with a phase, while mgr. must remove head's bias by supplying them with developments required of admin. program as whole. Reports should contain what mgr. desires and not what his subordinates want to publicize. Outside data and officials should be consulted as to methods, operations and reports, then mgr. and dept. heads endeavor to use these for improvements, if applicable. Generalizations regarding form of departmental reports impossible, conditions should govern, with object of improvement—not having report rut. Reports should, however, be consistent to facilitate comparisons. Present and future value of periodic reports depend upon their application. Report not used is wasted, while report given hard usage not only stands up, but usually improves. *Ibid.* **24:** 13 (Jan. '42). *V. Administrative Codes, Rules and Regulations.* Organization and admin. detd. by daily contacts of city mgr. and leadership characteristics. Mgr. may bring certain materials together for adoption by city council as ordinance. Admin. manuals used as guides for admin. action; admin. regulations pertain to general policy and procedure, being prepd. for employees' guidance. Many city depts. authorized by charter to issue rules and regulations affecting citizens, which have force of law. Main objective of admin. regulations, manuals, etc. is for information and guidance. Ordinances affecting conduct of citizens subordinate legislation, generally requiring council's approval. *Ibid.* **24:** 39 (Feb. '42). *VI. The City Manager's Relations With the Council.* City mgr. chief administrator, represents admin. organization in relations with council. He is appointed by and responsible to council, hence council can delegate to him considerable discretion. Powers described by law; admin. relationships are not; mgr. must consult council and latter depend upon him. Council-mgr. plan unification not separation—mgr. administrates policies, but council responsible. Subject matter, munic. govt., cannot be divided into policy and admin., both must co-operate. If council minority attacks mgr., politically he must be neutral. First it is essential that there be an understanding of fundamental principles of their admin. relationship; mgr. has only and exclusive control over admin. He interprets technical aspect of local govt. to council, initiates recommendations for legislative action, must give advice and recommendations even on controversial matters. Responsible to council and should not compete with it for public acclaim; may publicly advocate and endorse council actions. Mgr. should be familiar with matters before council, thus being prepared to answer questions; his periodic reports show expenditures and unexpended balances of all budget accts. City attorney's attitude may determine whether numerous repetitive actions necessary by council preceding admin. action; or council may determine gen. policy and entrust admin. to mgr. He should have city atty. determine what power council can delegate to him. Council may seek legislative or charter amendments to eliminate detailed legislation. If mgr. responsible for admin. of policy, council must delegate adequate authority. Right of mgr. to appoint dept. heads and subordinates. Councilmen secure information from mgr. Complaints relative to admin. matters should be dealt with by mgr. in a regularly established routine. System should be installed so that matters referred to mgr. by council are promptly handled by dept. heads. City mgr. and council should have a mutual understanding of basic principles involved in working relationship. Mgr. may contribute to establish-

ing such relationship if he keeps in mind his responsibility to council as collective body for the whole admin. Plan avoids mgr.'s participation in factional disputes and lessens effect of partisan politics on govt. by intelligent leadership. Relationship keystone of effective council-mgr. govt. *Ibid.* **24:** 73 (Mar. '42). *VII. Relations With Other Local Governments.* City govt. not isolated. Necessarily relationship with govtl. colleagues and neighbors. External relations complicated where no. of boards and commissions in a city. Boards not separate units of govt., as, generally, they do not have independent taxing powers. Co-ordination of activities therefore complicated and must be attained by common agreement, not by legal authority. City mgr. needs thorough understanding of power and duties and organizational setup of these boards. If mgr. not a member of independent boards; he may make it clear that he is not competing with them, invite them to meetings when subjects are discussed which might affect their field, deal with them in an informal manner, place at their disposal the services or advice of regular city depts. If he is member of the boards, he can show how their service fits in with whole. If he recommends to the council adverse action on a board's recommendation he may feel at a disadvantage by being a board member and feel an overlapping of legislative and admin. functions. Municipalities need city charter or state legislative authority to effect special arrangements or perform certain new services. This comparatively easy to secure, cities having been permitted to supply water service outside city limits. May be exchange of general services, as advisory facilities to joint planning, and scheduling of activities which might overlap, e.g., temporary loans and joint use of equipment and personnel, performance by one governmental unit of service for another, joint performance of a service. Legality of such steps must be considered, likewise liability involved. *Ibid.* **24:** 103 (Apr. '42). *VIII. The Manager's Rôle in Public Relations.* By his own contacts with public and by his direction and control of the contacts of subordinates, mgr. chief public relations officer of city govt. Many phases of public relations can be assigned to personnel with specialized training, but ultimate responsibility for public relations belongs with the chief administrator. He cannot delegate or evade such responsibility without impairing operating effectiveness and public relations. Majority of mgrs. reporting, follow "open door policy," but not seeing any visitor at any time. None use form letters in replying. Letters dept. heads can answer referred to them, but mgr. acknowledges communication. As one mgr. expressed it, "good method of detg. when mgr. should speak and when he should not is simply to det. in his own mind whether or not he is logical man in community to speak on particular subject." Difference of opinion as to advisability of membership in lunch clubs and civic organizations. Several thought mgr. might hold minor or honorary offices; several cautioned against holding offices in organizations that take official stands on matters of public policy. Important that subordinate officers and employees maint. good public relations stds. and practices. Promptness in adjustment of complaints especially emphasized. If complaint is adjusted on day received, citizen impressed by efficiency of his govt. None of mgrs. reporting has made direct use of various scientific devices of opinion sampling—regarded as in laboratory stage or requiring specially trained investigators for reliable results. Mgrs. asked for opinion on what has done most to improve public relations. Replies mentioned: new public service or activity; general admin. policies such as strict adherence to merit system in munic. employment or pay-as-you-go policy. Answers indicate good public relations not merely attained by publicity, but that essential prerequisite is efficient admin. of munic. services. *Ibid.* **24:** 138 (May '42). *IX. Research and Planning in Management.* Research essential to understanding problems. Successful mngmt., however, depends in large part upon quality and amt. of constructive thinking by mgr. Council's primary source of information is city mgr. Information received by council from other sources should be examd. often reinterpreted or supplemented by mgr. Sources

of information are govt. agencies, specialists and agencies in particular subject and those mostly concerned by action to be taken. After council fixes policy, mgr. and dept. heads must formulate and det. admin. policy. Heads of operating agencies should be alert to possibilities of study and investigation. Better the various dept. heads understand problems of their agencies, more helpful they are to mgr. in devising gen. admin. policy. If city does not have research workers, research can be done by operating personnel and is essential, unless agency desires to stay in rut. Mgr. cannot be technically competent in all complex activities, but can make certain those responsible keep abreast of progress. Admin. research must be done by those understanding functions and tasks of dept. Research becomes basic element in process, if budget making is conceived as a continuous and rigorous scrutiny of operations, policies, facilities and work methods. In smaller cities, research will be by mgr., asst. or operating personnel. Important that mgr. develop favorable attitude toward inquiry. In general, research should be delegated to subordinates. Operating agencies should understand importance of research. Full use should be made of outside sources for information. Someone should know where to procure information. Need for research in govt. arises from inescapable fact that decisions have to be made. *Ibid.* **24:** 168 (June '42). *X. Training as a Management Function.* Mgr.'s job to develop subordinates, to improve their performance by improving their knowledge, attitudes and skills; he is responsible for their training. Probably in most cases policemen and firemen only ones who receive inside training, this primarily for results. Some cities train other employees. In some cases where college near city, college gives special training courses. Should training be optional or compulsory? If employee does not wish to take training he probably does not desire advancement. Incentive to employee to take training is reward, although this not guaranteed. Wide variety of practices and policies as to who pays for training—if compulsory, generally by city. Some reporting cities grant short leaves of absence for training, that for high-ranking officials held after working hr. Conclusions and recommendations: top-level training necessary, competent instructors essential, training committees should be composed of a cross-section of officials and employees, responsibility for training should be more clearly defined to broaden employees and prevent duplication of effort.—*Samuel A. Evans.*

What the Public Utilities Will Find in Inflation. K. KAUFFMANN-GRINSTEAD. Pub. Util. Fort. **29:** 267 (Feb. 26, '42). Unless all signs fail, Am. business facing another adverse set of circumstances. Crisis affecting non-war activities will reach finance as well as operation. All would like to avoid inflation; ignoring facts is courting disaster. Am. business willing to assume initiative in pointing way to changes in public opinion; diplomatic and intelligently effected changes then reflected in acts of regulatory bodies. Am. inflation in utilities will probably not be as bad as European, but study of European advisable. Drain on capital one of problems management must solve. Cause of losses in German utilities was that they had, to great degree, to live on their substance. During inflation operating expenses went up faster than income. To keep alive, then, use of capital and surplus mandatory. Warnings show Am. public utilities facing similar situation, rates do not advance as fast as expenses. Pub. utility executives point out that regulation has approached regimentation and consequently public lost confidence in their being able to grow and prosper. Military and political experts predict at least 2 or 3 yr. war, maybe 5 or longer. Probably half of our raw materials and finished products will be required—result domestic scarcity. Hardly possible to fix prices with labor cost advancing. When effect of increased wholesale prices felt, living will probably have advanced 50%, maybe 100% or more. After war, danger of inflation even greater. Problem facing Am. utility managements will increase in complexity involving capital and operation. During French inflation, regulatory tribunals sanctioned sliding

scale of utility rates dependent upon production cost increases. Result, utilities of France fared better than others. Emergency great enough to warrant utility managements interesting the federal govt. at least for duration. Sliding scale will gain valuable production hours otherwise lost in negotiation and hearings. If increase in liquid capital, it should be used to retire bonds and preferred stocks. Need good will and co-operation of employees.—*Samuel A. Evans.*

All Utility Companies Need Is a Square Deal. ERNEST R. ABRAMS. Pub. Util. Fort. **24:** 333 (Mar. 12, '42). Regulation of pub. service institutions established procedure for past 35 yr. Every state except Del. now controls one or more forms of pub. service, federal regulation of pub. utilities arrived with "New Deal." Public services now faced with 3 problems among others: (1) possible reduction of fair rate of return; (2) regulatory authorities denying utilities right to deduct income and excess profits taxes before computing rates of return; and (3) chance utilities will be required to acct. depn. for all purposes at rates reported to federal taxing authorities. Whether regulation administered with understanding or prejudice, objectives co-operative or primitive, end-result always is ceiling on earnings. On avg., utilities require 8 times as much capital as gen. run of industries to produce dollar of annual gross revenue. If utilities required by S.E.C. to raise capital by sale of common shares, purchasers will want assurance of adequate reward for their funds. If municipalities take over public services, cost would undergo apparent reduction, eventual savings to cash customers nil; such transfer from private to public would involve serious loss of revenue to federal govt. Utilities obligated to provide adequate and continuous service at fair rates; public obligated to permit utilities fair and reasonable compensation for use of capital. Arbitrary stds. fixed by Internal Revenue Dept. have been responsible for privately owned public services reporting depn. to stockholders and regulatory commissions at rates below those reported to federal taxing authorities.—*Samuel A. Evans.*

Survey of Real Estate of the Water Supply System, New York City. *Report on W.P.A. Project No. 665-97-3-94.* Dept. of Water Supply, Gas & Elec., N.Y. City. (Mar. '41). Since '17, no effort to correlate Dept. property records of some 50,000 acres acquired "in fee"; several thousand parcels of water rights and various easements. Since '18, no. of water supply parcels released for crossings, parks or other pub. purposes. Impossible for one not directly connected with Real Est. Div. readily to det. city's property interest at given point. W.P.A. project eff. made vast amt. of detailed data easily accessible to all. Report gives historical background and general description. Divisions included are: indexing, title searching and research, eng. maps, tax records, and latter by areas. Appendixes include: sample condemnation proceedings record book, list of completed ones, list of completed atlas, maps, compilation of tax records, also latter by areas, for town of Bedford.—*Ralph E. Noble.*

The Professional Status of Chemists. ANON. Science. **95:** 268 (Mar. 13, '42). Professional status of chemists upheld by Natl. Labor Relations Bd. in decision that professional employees should not be forced into bargaining unit composed of misc. group of skilled and unskilled workers as well as professional employees. Held that only majority group itself can det. desires on issue of union representation. Arose from matter of Shell Development Co. and Int. Fed. of Architects, Engrs. Chemists and Technicians (Case R-3245). Issue whether union, having signed up certain no. employees in particular plant, could reach out and corral almost equal no. employees, who desired not to have that union represent them, and arbitrarily exclude from its proposed unit numerous other employees uninterested in scheme and whose votes would mean loss of election.—*Ralph E. Noble.*

A Design for Building Good Will. JAMES E. DAVIDSON. Edison Elec. Inst. Bul. **10:** 43 (Feb. '42). Corporation, according to English and Am. common and statute law, is "body politic or

corporate formed and authorized by law to act as a single person." Definition embraces whole problem of public relations, each individual in corp. must deal with public to win respect, friendship and approbation for corp. Public likes to transact business with companies whose commodities and services superior and whose executives and employees friendly. People complain about high utility rates when public relations poor. Confidence of customers must be won and held; customers will destroy more public good will in day than can be built in months. *Esprit de corps* must exist among employees. Can be attained by careful selection of personnel, proper training and promotion by merit. Company's employees should be kept informed about firm's current activities, each year employee receiving annual report. Officers and employees can keep public informed about corp. and service rendered. Corp. should: seek and fulfill civic responsibilities; be courageous and aggressive, yet tolerant; know what customers think about corp.; show maintd. interest in customer; tell customers all they should know about corp. —*Samuel A. Evans.*

LAW, LITIGATION AND LIABILITIES

Selected Problems in the Law of Water Rights in the West. WELLS A. HUTCHINS. U.S. Dept. of Agric. Misc. Pub. No. 418 ('42). [Publication most comprehensive and understandable.] Law of water rights highly specialized branch with rate of change noticeably accelerated. Surface waters classified as: (1) diffused, (2) watercourses, i.e., well-defined channels or integral parts of stream system, (3) lakes or ponds not connected with stream system, (4) springs and (5) waste waters. Subsurface waters are: (1) ground waters flowing in defined subterranean channels and (2) diffused, percolating waters. Water right, attached to watercourse, is right to use of flow, not private ownership in water corpus, whether grounded upon riparian land ownership or statutory right of appropriation. Such right real property. General rule, Calif. excepted, water diverted from natural resource and reduced to phys. possession becomes personal property. Exception—water in reservoirs or pipe lines as to sale, theft and taxation. Western law embraces 2 diametrically opposed principles, *viz*, common-law doctrine of riparian rights and statutory doctrine of prior appropriation. Under former, owner of land contiguous to stream has certain rights in water flow by virtue of land ownership. Under latter, first user acquires priority right to continue use regardless of land contiguity. Both doctrines in effect concurrently in some states; one to exclusion of other in other states. Riparian and appropriative rights equally entitled to legal protection. While in conflict, adjustments made in specific instances by courts. Rights to use of watercourses largely matter of state law. Appropriation doctrine applies generally to navigable and non-navigable watercourses. States recognizing riparian doctrine not uniform in applying same to navigable waters. Trend toward restricting application of common-law (riparian) doctrine, thus increasing development under appropriation doctrine. Application of doctrine in several states cited with cases. Diffused surface waters flow vagrantly over surface or stand in bogs or marshes; not concentrated in watercourse. Earlier and usually litigation over such waters arose: (1) between neighboring landowners to prevent flow across property from above, claiming right to turn it back upon neighbor's property and (2) over land protection from stream overflow. Some, between individuals, concerned landowner's right to make beneficial use of water. Now, broader questions involved. Soil conservation and other programs concern right of control and use. Necessary to det. landowner's rights and liabilities to diffused waters on his land. Is it absolute right to withhold such waters; or qualified by rights of others; or subordinate to potential appropriators rights? Importance of problem arises from fact upstream large-scale control operations

may alter flow. Law of diffused waters largely distinct from law of watercourses. Where landowner's right to utilization on his land directly at issue, western courts held he may appropriate them to own use, although question squarely decided in only few cases. Lower landowner, therefore, cannot require continued flow from above. Diffused waters may be subjected to possession and use by any process of capture and retention on own land without injury to other's land thereby, or by disposal of unused water. No limitations placed upon character of structure used. All diffused waters augmenting stream flow are phys. sources thereof, but decisions silent whether they constitute legal tributaries. Individual state laws det. whether diffused surface waters belong therein to watercourse. Adoption of common or civil law rule does not appear to control appropriability of such waters. Most of the Western States have dedicated all or some waters to public for beneficial use. Such acts of dedication subject to vested rights. Waters subject to appropriation specified in Western States statutes and generally consist of dedicated waters. In states in which appropriation statutes apply literally to diffused waters, courts not yet held latter subject to exclusive appropriation against landowner's will, but long established uses of drainage water upheld and some courts stated broadly all waters physically tributary to stream subject to appropriative rights therein. Except where special statute prevailed, diffused surface waters collected in channel usually held subject to appropriation only where channel considered as watercourse. Controversies over appropriability of diffused surface waters have not involved rights of claimants on watercourses. Rights to diffused surface waters not adequately correlated with rights to watercourses. In most of the Western States protection of appropriative right in watercourse probably extends to all tributary channels, even though latter under other circumstances might not be considered watercourses. When surface waters truly diffused, coordination of rights of landowner and appropriator of stream toward which they flow require adjustment of conflicting principles. Possible to co-ordinate on basis of reasonable use. Public welfare aspect of watershed protection program important therewith. Regarding ground waters, courts generally differentiated between waters flowing in defined subterranean channels and those unconfined or "percolating waters." Ground-water classes subject to different rules of law. Rules applicable to surface watercourses apply to defined underground streams. Some statutes specifically subject such water to appropriability which invariably upheld by courts. Underflow is part of stream. Underground stream has essential elements of surface watercourse but burden of proof upon party asserting its existence. In absence of statutory declaration, tendency to apply doctrine of absolute ownership (English rule) to landowner of overlying land, adopting modifications later. Injustices resulting from unreasonable withdrawal of water by landowner resulted in some courts imposing measures of reasonable use (American rule) or correlative right. Generally, appropriation may be applied to all percolating waters, ground waters in designated classes having reasonably detd. boundaries and surplus above reasonable requirements of overlying lands. Artesian waters appropriable in some states, not in others. Is appropriator from underground source entitled to enjoin junior diversion from same source, resulting in lowering ground water table, thereby forcing higher operating costs on senior appropriator? Decisions accord appropriator substantial protection in reasonable means of diversion. Decisions in 4 states afford substantial protection to appropriator in use of existing pump equip. First appropriator under ground water appropriation statutes probably has little grounds for insisting on maint. of ground water level at point of first pumping, if appropriation can be satisfied within conditions detd. by state engr. as affecting safe yield. Absolute ownership doctrine apparently not decided in reasonable-use states where taking for distant use not involved. Several rules of ground water law summarized for each of 17 Western States, covering constitutional and statutory

provisions, waters in definite underground channels, percolating waters, etc. Whether landowner has exclusive right to use spring water on his land depends upon whether flow remains thereon. If spring waters dedicated to public, prior to acquisition of private right use, landowner can only acquire exclusive right to use by appropriation regardless of flow therefrom. If latter in defined stream constituting watercourse, law of latter held to apply and he has no exclusive right by virtue of land ownership. Appropriations of springs on public land protected against claims of subsequent entrymen. Rights to spring waters may be lost through adverse possession and use by another, by estoppel, statutory forfeiture and abandonment. Several rules of spring water law summarized for 17 Western States. Operation of appropriation doctrine involves problems of definite quant. of water, definite period of use, rotation in use, phys. diversion, location on another's land, avoidance of unreasonable waste through diversion and conveyance as measured by locally prevailing customs, particular purpose, definite place of use and question of land ownership as prerequisite to appropriation right. Priority right dets. right to divert water when supply insufficient for all. Appropriative right may be acquired for beneficial purpose only. Beneficial use modified by requirement of reasonableness measured by all circumstances including local customs. Domestic water use by farmers implies for preservation and maint. of household, including watering of domestic animals and probably irrigation of family gardens. Appropriation may be made for water storage. Appropriative right exclusive in character in that it is specific, carries fixed priority, defendable and protectable as property right against interference with its proper exercise. Protection right extends in general to all sources of water supply. Appropriator entitled to so much stream flow to point of diversion as necessary to satisfy prior right but right of protection limited to quants. useful to prior appropriator. Protection afforded only against interferences causing material and substantial injury. Junior appropriator entitled to have senior ones held within scope of their appropriations as of date of junior priority. Many state constitutions and statutes grant preference in water use. Appropriative rights restrictable in public interest. Reservations in favor of municipalities. Water appropriated and diverted from stream may be conveyed through natural channels (ditches, reservoirs) without loss of ownership. With some exceptions, water may be appropriated for use in watershed other than that in which originally diverted. Waste water may be appropriated, within limitations, but generally original user not obliged to continue waste. Seepage from irrigated lands becomes part of stream into which it flows, at least if no intent on part of irrigator to recapture it. Natural accretions to stream become part thereof. Right to use portion of stream flow salvaged by artificial improvements belongs to one making them. Right to use new water added to stream belongs to one responsible for developing new supply. Burden of proof upon party claiming right to use waters developed by himself. Right to change point of diversion, place and character of use permitted, ordinarily, provided rights of others not impaired. Appropriative right usually appurtenant, but not inseparably so, to place of use. Being real property, water right subject to transfer with same formalities required for conveying real estate. Under exceptional circumstances title to water rights may pass by parol. Loss of appropriative rights same as under spring water rights. Right to appropriate water within one state for use in another is at sufferance of first. Several placed restrictions on such rights; some enacted reciprocal legislation. In controversy over water use of interstate stream, each state entitled to equitable apportionment of benefits from use. Some states resort to compacts for adjustments of conflicting interests on interstate streams. Structures (dams or diversion head-gates) affecting water use on watercourses must be operated with regard to requirements of downstream prior claimants. Those which detain water for brief periods may complicate equitable administration of downstream water rights. Widespread

control of diffused surface waters throughout drainage basin will necessarily affect water flow in surface drainage channels. Rights to diffused surface waters and water in watercourses interrelated. Right to use water for stock governed by water rights law in each jurisdiction. Ownership of unappropriated waters not yet squarely settled in view of fed. interest in development and use of water for purposes other than navigation. Case pending. Appendix includes abstracts of state statutory provisions relating to important principles governing appropriation of water, determination and administration of rights (with list of cases) in 17 Western States.—*Ralph E. Noble.*

Law of Overflow. LEO T. PARKER. Sew. Wks. Eng. **13:** 357 (July '42). Well known that municipalities, or others, not responsible for injuries to persons or private (pvt.) property caused by "Act of God." Latter, however, *never* an occurrence usual and anticipatable by prudent persons. Applicable to damages resulting from windstorms, floods and like. *City of Austin* v. *Howard*, 158 S.W. (2nd) 556, reported Mar. '42. In '36, municipality established several-acre sewage disposal plant between pvt. property (in close proximity) and main river channel. To protect plant from flood, erected levee completely around. In '38 flood, stream overflowed and damaged pvt. property. Owner filed for damages. City contended latter not recoverable because '38 flood unprecedented; thus, "Act of God." Testimony developed that '35 flood 6″ or 7″ higher. In view of this, higher court (ct.) held damages recoverable because '38 flood could reasonably have been anticipated. "Natural course" means stream in real sense with definite channel, bed and banks, not a gathering of errant water while passing through low depression, swale or gully. Any person firm or corp. causing natural stream to overflow, whether or not through negligence, liable for resultant damages. *Scott* v. *Watkins*, 122 Pac. (2nd) 220, reported Mar. '42. Co. constrd. dam across stream and installed drainbox to carry off excess water. Privately owned land flooded because drainbox capac. insufficient for purpose. Ct. held property owner entitled to damages. Although damage to pvt. property *may be* caused by negligence, yet neither municipality, county or state liable if cause remote and not directly connected with alleged negligence of such agencies. *Lamb*, 73 Cal. 125. Reclamation Dist. constrd. levee along west bank of Sacramento R. After 7 yr., levee overflowed, damaging crops of adjacent landowners who sued state to recover damages. Ct. held state not liable as it was indirect, remote, temporary and unpredictable as to reoccurrence. In a sense, such remote cause may be legally classed as "Act of God." Same non-liability present. Various higher cts. held person, firm, co., state, county, city liable for damage by overflow when same definitely estabd., (1) if cause of overflow could have been elimd., (2) if overflow anticipatable by exercising ordinary prudence, (3) if source of overflow danger constrd., maintd. or harbored and, *for any reason*, overflow results. Well established law, if one, for own purposes, brings on his property, collects and keeps there anything likely to cause mischief if it escapes, he must keep it in at his peril. Otherwise, *prima facie* answerable for all damage in consequence of its escape. *Central Ind. Coal Co., Inc.* v. *Goodman*, 39 N.E. (2nd) 484, reported Feb. '42. Coal Co. dug, left unfilled with earth, large, deep, wide excavation, mile or longer. Water in channel and excavation became pold. and dangerous to plant and animal life. Channel overflowed, damaging adjacent property. Also *Beaver Dam Coal Co.* v. *Daniel*, 227 Ky. 423. Copperas water from mine discharged into stream which later overflowed. Not only one liable for damages to persons and property *directly* caused by illegal water overflow, but also for incidental or indirectly resultant damages. Thus, law well established that one artificially accumulating surface water upon his land and discharges water so accumulated upon pub. street, walkway or highway where it freezes or otherwise renders same dangerous, liable for injury resulting therefrom to traveler using due care. *Miller*, 24 Atl. (2nd) 421, reported Mar. '42. Mu-

nicipal ordinance valid requiring persons intending to sue city to give notification within reasonable period after injury or damage occurrence. *City of Atlanta* v. *Scott*, 18 S.E. (2nd) 76, reported Jan. '42. Here, 90-day notice required.—*Ralph E. Noble.*

Diversion and Appropriation of Water to Beneficial Use Under Kansas Laws. GEO. S. KNAPP AND WARDEN L. NOE. Div. of Water Resources, Kan. State Bd. of Agric. (Jan. '42). Following principles recognized as governing chief engr.'s decision in granting, limiting, withholding or denying approval of application for permit for diversion and beneficial use of water. Any person using water in beneficial manner for lawful purpose Mar. 24, '17, considered as acquired some apparent right to beneficial use of such water, for reasonable needs, irrespective of whether he subsequently obtained permit approving diversion and use thereof; and his accrued rights and investments will not be interfered with or impaired, but given consideration and protection in granting, limiting or withholding approval of application for permit for subsequent proposed use of water from same source of supply. Right to divert unappropriated waters for beneficial use for reasonable needs not denied where waters from source of supply sought available in sufficient quant. for use of all applicants and present lawful users. Failure continuously to apply available water to lawful and beneficial uses, without due and sufficient cause shown, deemed abandonment and surrender of such right. Subsequently acquired to use of such water, however, shall not receive superior right of original user, but be subordinate and inferior to all permits for water diversion and use previously granted, governed by date applications filed therefor. Existing appropriations of water for different purposes take following order of precedence: domestic, irrigation, indus. and water power. Issuance of approval of applications not assurance of sufficient available supply, nor guarantee of protection by state against other claimants who acquired, obtained or established superior or prior right to divert and beneficially use water for lawful purpose. No specific provisions for filing applications to place of record in state office, any vested, accrued or riparian claims to right to divert and use water which existed prior to Mar. 24, '17, except by court adjudication under provisions of sections 42-3109, 74-509c, 74-509d, and 74-509e. Approval of application not a permit or certificate of appropriation. Such approval merely authority to begin constr. of diversion works, if plans and specifications otherwise submitted for required approval under provisions of sections 82a-301 to 82a-305 inclusive. Proof of actual utilization of water sought must be submitted and approved before permit or certificate issued.—*Ralph E. Noble.*

Validity of Modern Health Laws and Regulations. LEO T. PARKER. Sew. Wks. Eng. **13:** 202 (Apr. '42). Modern courts hold that in its duty to protect pub. health, city not acting in private or proprietary capac., but purely governmental one, in discharging one of highest duties to citizens. Authority of state legislature over munic. corp. supreme, yet subject to constitutional limitations. Particularly applicable to water poln. controversies. In *State* v. *City of Juneau* (300 N.W. 187 (Nov. '41)) State Bd. of Health and State Com. on Water Poln. entered order that named municipality: (1) take immediate steps to secure detailed plans and specifications for complete sew. treatment system or plant adequate to meet local needs, and submit same to State Bd. of Health for approval according to statutory and code requirements by given date; (2) that sew. treatment system or plant be installed without delay. Order based upon decision that discharge of inadequately treated sew. is pub. health menace, nuisance interfering with peace and comfort of residents and others along stream and making it unfit for watering livestock. City refused to comply. State filed suit to compel compliance. Higher court held city must comply saying law gives Water Poln. Com. authority to adjust order to achieve statutory purpose by adequate means. *Procedure administrative.* Discretion vested in State Bd. of Health and State Com. on Water Poln. not arbitrary but

subject to court review. Rights of all parties fully protected. *When stream pollution is lawful.* Modern higher courts consistently hold that right to pour surface drainage into river or other stream does not include right to mix noxious substances to extent stream cannot dilute same, nor safely carry them off without injury to property of others. In effect, latter act appropriates river bed as open sewer and invasion of property rights. When done for private purpose, unjustifiably wrong; for pub. purpose may become justifiable but only upon compensation for property thus taken. *Purification—recognized necessity.* Purif. of obnoxious substances before pouring into river becoming recognized as necessity by modern courts. However great the necessity, cannot act to limit right to compensation to damaged property owner, as in case of *Snavely* v. *City of Goldendale* (117 Pac. (2nd) 221 (Oct. '41)). Tort-feasors who, independently, contribute to common injury, may be joined as defendants in same action. *Nuisance liability.* Irrespective of whether water poln. caused by negligence of city officials, if legal nuisance, municipality may be held either liable in damages or compelled to condemn or appropriate depreciated property and pay owner reasonable valuation. Another important point of *new law*, if either owner of private property or municipality maints. nuisance and deposits refuse or sew. in running stream thus polg. waters, fact that lower owner or municipality had also cast foul or unwholesome material into same stream would not defeat right to recover for so much of damage as attributable to wrong of city officials. Illustration: *City of Weatherford* v. *Luton* (117 Pac. (2nd) 765 (Oct. '41)). *Legal effect of injunction.* Higher courts held that where nuisance abatable, injunction may be granted without necessity of condemning or appropriating property and paying owner reasonable cost thereof. Moreover, court may specify details as to when and where nuisance acts must be performed and accomplished. Example, *Kuhn* v. *Wood*, 36 N.E. (2nd) 1006 (June '41).—*Ralph E. Noble.*

Court Decision on Public Health. *Records of County Health Commissioner Concerning Typhoid Carrier Held Not Privileged.* (N.Y. Ct. of Appeals; *Thomas* v. *Morris et al.*, 36 N.E. 2nd 141; decided July 29, '41). Pub. Health Repts. **57:** 281 (Feb. 20, '42). Action brought by plaintiff, as administrator, for damages for death of person from typhoid fever. Alleged that fatal bacillus transmitted to decedent by negligent conduct of defendant, who prepared and handled food served to decedent, guest at defendant's hotel, notwithstanding defendant was, to her own knowledge, typhoid carrier. Plaintiff sought order requiring county health comr. and state health dept. each to produce, at trial, records and papers as might indicate whether or not defendant a typhoid carrier; if so, defendant's knowledge of such condition; and if any information supplied her by above agencies to effect she could transmit disease to others. State willing but comr. opposed motion and appealed. Appellate div. reversed trial ct. order, holding records privileged. Case carried to N.Y. Ct. of Appeals which viewed trial ct. order correct and that official records kept by county health comr. could be made available to plaintiff.—*Ralph E. Noble.*

Pa. Public Utility Com. *v.* Westmoreland Water Co. Pub. Util. Fort. P.U.R. **42:** 290 (May 7, '42). Com. directed petitioner to construct certain extensions and initiate water service; water co. petitioned for rehearing which was denied. Formerly, petitioner given opportunity to present evidence and testimony. In former order com. found record insufficient for a reasonably accurate finding of reproduction cost or new or accrued depn. thereon. Without evidence of original or historical cost, record is void of sufficient evidence for finding of fair value. If petitioner had competent evidence and testimony and did not offer same, fault lies with petitioner. Petitioner pleaded increased constr. costs. Com. ruled that these were not sufficient to justify not constructing extension. Opinion expressed that in extension, as well as rate proceedings,

time must come when record shall be finally closed in order that com. may perform duty as regulatory body. Petitioner alleged constructing extension would be confiscation of property. Burden of proving such confiscation upon petitioner for rehearing. Water co. given definite time to complete constr. and initiate service.—*Samuel A. Evans.*

City Must Pay Damage for Shutting Off Water. ANON. Eng. News-Rec. **127:** 331 (Sept. 4, '41). On Aug. 27, superior court of Montreal, Que., ordered that city to pay Holdsworth Co., Ltd., $717 damages for cutting off firm's water supply. Company had sued city for $1,991, including $1,150 for alleged loss of a customer, claiming that interruption of supply had caused firm to dye certain materials darker than desired. Trouble originated in conversation between city's foreman and company repr. about turning off water for few hours. Foreman somewhat deaf and had little knowledge of English language. Company repr. claimed he had made known fact that it would be necessary to continue water service for another 2 hr., while foreman stated that he had understood that it would be all right to stop flow at once and keep supply shut off for 2 hr. Following conversation, water was shut off almost immediately.—*R. E. Thompson.*

Federal Power Com. v. Natural Gas. P. Co. of America. *U.S. Supreme Court.* Pub. Util. Fort. P.U.R. **42:** 129 (Apr. 9, '42). Court sustained validity of F.P.C. order reducing gas rates. *Findings:* Congress has authority to regulate prices of commodities in interstate commerce. Companies cannot complain that they were denied a full hearing—right to a full hearing before any tribunal does not include right to challenge or rely on evidence not offered or considered. Statutes direct com. to det. just and reasonable rates. Lowest reasonable rate is one which is not confiscatory in constitutional sense. Com. free to decrease any rate which is not lowest reasonable rate. Courts without authority to set aside any rate adopted by Com. as too low if consistent with Constitutional requirements. Rate-making bodies not bound by Constitution to service of any set formula. If fair hearing given, proper findings made and statutory requirements satisfied, courts cannot intervene unless limits of due process have been overstepped. Com. declined to include going concern value as addnl. item in rate base. No constitutional requirement, when going concern value is appropriate element to be included in rate base, that it must be separately stated and appraised as such. When property is to business which can only exist for limited term, any scheme of amortization which will restore capital investment at end of term involves no deprivation of property, allowance of amortization in excess of cost refused by Court.—*Samuel A. Evans.*

North Dakota Supreme Court. *Northern States Power Co.* v. *Board of Railroad Commissioners.* Pub. Util. Fort. P.U.R. **39:** 219 (Sept. 11, '41). Dist. Ct. vacated orders of Bd. of R.R. Comrs., Sup. Ct. affirmed judgment and remanded case with instructions, with following findings. Rate return for utility based upon reasonable fair value of property used and useful for public service. In detg. fair value, increase or decrease from original cost must be considered, unless increase would result in unfair rates to public. Going concern value must be considered in rate-making, which does not include good-will or franchise value. Comrs. must exercise judgment based upon evidence of expenditures and cannot substitute their opinion therefor, nor can they arbitrarily set lower figure for fair avg. legal expenses than were incurred. Comrs. obligated to make findings of fact upon all matters having a bearing upon rates, all findings of fact must be sufficiently definite to permit reviewing ct. to det. if evidence supports them.—*Samuel A. Evans.*

Re: Kentucky Utilities Company. *Opinion and order, Kentucky Public Service Com.* Pub. Util. Fort. P.U.R. **41:** 129 (Jan. 29, '42). In past 16 mo. com. has required utility to inaugurate 2 substantial rate reductions. Apparently '41 income will be in excess of what com.

believes fair return. Com. deems it unwise in view of unsettled economic conditions to require co. to reduce rate schedules now. Future upward revision might be necessary. Com. believes formulation of plan necessary to dispose fairly of any anticipated excess '41 revenues. Depn. for reserve found inadequate, any excess revenues should be applied here. Following ordered: Co. allowed certain sum as earnings; any excess proportioned 50% to reserve depn. acct. for plant; remainder distributed to consumers as promptly as possible. These findings not to be construed as a precedent.—*Samuel A. Evans.*

HEALTH AND HYGIENE

Distribution of Health Services in the Structure of State Government. Joseph W. Mountin and Evelyn Flook. *I. The Composite Pattern of State Health Services.* U.S. Pub. Health Repts. **56:** 1673 (Aug. 22, '41) Reprint No. 2306. *II. Communicable Disease Control by State Agencies. Ibid.* **56:** 2233 (Nov. 21, '41) Reprint No. 2334. *III. Tuberculosis Control by State Agencies. Ibid.* **57:** 65 (Jan. 16, '42) Reprint No. 2348. *IV. Venereal Disease Control by State Agencies. Ibid.* **57:** 553 (Apr. 17, '42) Reprint No. 2369. *V. Sanitation by State Agencies. Ibid.* **57:** 885 (June 12, '42). Current pub. health programs, embracing 35 separate activities, blend old and new concepts re pub. responsibility in community and personal health. Basic objective of any such program always been control of communicable disease. Environmental sanitation one of outstanding pub. health weapons, includes stream poln. prevention; milk, shell-fish, food, food-handling sanitation; swimming pools, bathing beaches, roadside picnic grounds, camps, comprising recreational sanitation; housing and plumbing control; garbage collection and disposal; control of insect vectors of disease. "Public" water supplies and sewerage systems serve community; "private" ones serve family; "semi-public" ones designed for tourist camps, roadside parks, comfort stations, indus. establishments, schools, hospitals, etc. Thus san. control ranges from design and operation of complex munic. water purif. or sewage treatment plant to location of private well or septic tank. For most part, state concerned primarily in routine control of pub. facilities, secondarily with private and semi-private. At same time, indus. wastes, representing source of stream poln., receive particular attention. Health dept. official agency with major responsibility, but in ¾ of jurisdictions, 1 or more state govt. units collaborate on special features of program, e.g., several depts. of labor help regulate indus. water supplies and sewerage systems; school sanitation sometimes joint concern of depts. of education and health; state universities co-operate in training operators of water and sewage treatment plants; special san. water boards and coms. supplement health dept. services in stream poln. prevention. Divided control obtains to greater deg. in sewerage than in regulation of water supplies. Many different instances cited involving jurisdiction and control of given agencies. [Impression one of confusion], yet obviously definite pattern to state activities for safety of water supplies and sewage disposal facilities, not only as to program content but also from standpoint of agency primarily responsible and types of auxiliary agencies participating in special features of complete control plan. Recognized that considerable variation obtains among states in extent and intensity of service; yet significant in this field of pub. health, some agreement reached as to effective control methods and scope of state responsibility.—*Ralph E. Noble.*

Sanitary Engineering—A Distinct Profession. Arthur B. Morrill. Sew. Wks. Eng. **13:** 143 (Mar. '42). Paper based on 2 simple ideas: (1) san. eng. a distinct branch of eng. profession, not modification of civ. eng., and has suffered from failure to observe this distinction. (2) no. of students of basic san. eng. subjects in under-grad. courses too small, so that vocational guidance efforts neces-

sary to correct situation. To those practicing in field, becomes increasingly obvious how relatively useless are some subjects usually taught and how important are some not given. According to up-to-date curriculum, san. engrs. still study topographic dwgs. and gen. surveying. Latter has such broad application that one with training therein is loath to see it omitted. Many san. engrs., however, get into positions where advantageous to know less of surveying and more of mech. and chem. eng. Seems that historical accident rather than logic associated modern sewage treatment with civ. rather than chem. eng. Subjects not now taught to san. eng. students but urged by a prominent practicing engr. are: (1) microscopy and precise instruments; (2) mech. dwg. (instead of topographical); (3) eng. statistics; (4) fluid mechanics (instead of hydraulics); (5) ventilation eng.; (6) air and gas analysis; (7) industrial san. eng.; and (8) pub. health eng. To det. essential in eng. teaching, survey of field would be desirable. "Vocational Guidance Monograph on San. Eng.," prepd. by Prof. Thomas R. Camp for committee of M.I.T. alumni on san. eng. education, describes kinds of work to be done and in terms of gen. agreement. Of above list, author considers eng. statistics most important. Training in statistical methods indispensable to proper san. eng. instruction. Many measurements on which he must depend are of very low order of precision. Often not aware that definite math. technique exists by which to det. dependability of data. May attempt to choose between 2 sources of water or milk supply, using entirely inadequate bact. data. May try to compare eff. of 2 types of sedimentation tanks and reach wrong conclusions or do a lot of unnecessary work through lack of knowledge of statistical methods. Some san. engrs. have great need for information regarding use of hydraulic models.—*Ralph E. Noble.*

Monthly Variations in Death Rate and Principal Causes of Mortality in the Mexican States. Miguel E. Bustamante and Alvaro Aldama C. Rev. Inst. Salub. y Enferm. Tropicales (Mex.) **2:** 259 (Dec. '41). Statistics accumulated from '33 to '39 indicate that in 21 Mexican states highest mortality occurred in Aug. of each year, while in four other states largest number of deaths recorded in Apr. Whenever mortality curve showed 2 yearly peaks, following sets of conditions observed: in one, first high in spring attributable to pneumonia followed by second high in summer due to diarrhea and enteritis; in other, spring high followed in late fall or winter by another high attributable to malaria. Principal causes of death, as shown by separate reports from the 32 political subdivisions of Mexico, are: diarrhea and enteritis, pneumonia, malaria, violent deaths, pulmonary tuberculosis and dysenteries.—*J. M. Sanchis.*

Studies of Acute Diarrheal Diseases. *I. Differential Culture Media.* A. V. Hardy, James Watt, T. M. DeCapito and Maxwell H. Kolodny. U.S. Pub. Health Rpts. **54:** 287 (Feb. 24, '39). Compared eff. of 4 differential media for isolation of *Shigella dysenteriae* from fecal specimens. Desoxycholate citrate agar (Leifson), which inhibits most nonpathogenic fecal organisms and permits heavy inoculation, outstanding in value. Plain desoxycholate agar (Leifson) somewhat superior to E.M.B. or Endo, particularly for Sonne and "Newcastle" varieties. *II. Parasitological Observations.* Bertha Kaplan Spector, A. V. Hardy and Mary Graham Mack. *Ibid.* **54:** 1105 (June 23, '39). Study limited to cases of acute diarrheal disease, their household contacts and representative samples of different racial groups, Pueblo and Navajo Indians, "Spanish-Americans," and "Anglo-Americans," in southwest. Infestation of Indians (25.9%) greatly in excess of 10.2% *E. histolytica* incidence for 57,561 individuals in U.S. Incidence of 14.8% for "Spanish-Americans" also higher. Findings raise question of immunity to this parasite. Complaint of even minor intestinal disorder completely absent and incidence of "carriers" in diarrheal patients lower as compared with healthy individuals. Rarity of frank cases of clinical amebic dysentery striking. *III. Infections Due to the "Newcastle Dysen-*

tery Bacillus." A. V. HARDY, JAMES WATT, MAXWELL KOLODNY AND T. M. DECAPITO. Am. J. Pub. Health **30:** 53 ('40). *IV. An Outbreak of Bacillary Dysentery Due to the "Newcastle Dysentery Bacillus."* A. V. HARDY, S. FRANT, S. W. JARCHO AND E. G. SCHLOSSER. U.S. Pub. Health Rpts. **55:** 2101 (Nov. 15, '40). Explosive outbreak of 97 cases of bacillary dysentery occurred in N.Y. City hospital, involving nurses chiefly. Newcastle dysentery bacillus isolated from 79.4% of cases. 23 carriers found. Constitutional symptoms more severe than in infections with *Shigella dysenteriae* Flexner and *Shigella dysenteriae* Sonne. Coliform-inhibiting medium, desoxycholate agar, of superior value in isolating organism, particularly from carriers. Sera of cases and carriers contained agglutinins for "Newcastle dysentery bacillus" in amts. well above that in control sera. *V. An Outbreak Due to Salmonella typhi murium.* W. E. MOSHER JR., S. M. WHEELER, H. L. CHANT AND A. V. HARDY. *Ibid.* **56:** 2415 (Dec. 19, '41). Concerns outbreak of 238 cases of acute gastro-enteritis, with 1 death, in institution for mentally defective. Illness limited almost exclusively to inmates of 12 cottages served by common kitchen. *S. typhi murium* isolated by stool culture from 86 (36.1%) of cases. Convalescent carrier state in 195 patients found longer than usually expected. 1 patient carried organism 18 wk. *Salmonella* and *Shigella* infections compared in certain respects. *VI. New Procedures in Bacteriological Diagnosis.* A. V. HARDY, JAMES WATT AND T. M. DECAPITO. *Ibid.* **57:** 521 (Apr. 10, '42). Used S.S. (*Shigella-Salmonella*) agar since Jan. '40. In parallel with desoxycholate-citrate medium, S.S. agar yielded significantly greater no. of pos. isolations. Full value of both highly selective media obtained only when whole surface inoculated with max. amt. of fecal material which will yield isolated colonies. High proportion of colonies differentiated most clearly after 18–24 hr. incubation. Some develop more slowly on desoxycholate agar. Highly selective medium and special rectal swab technique described in detail, simplified studies, allowed work expansion and increased proportion of positive observations. *VII. Carriers of Shigella Dysenteriae.* JAMES WATT, A. V. HARDY AND T. M. DECAPITO. *Ibid.* **57:** 524. "Convalescent carrier" applies to individual harboring *Shigella* following recovery from illness known due to this cause or following diarrheal illness not known due to any other cause. Considered such up to 1 yr. after recovery if same variety of *Shigella* harbored. "Passive carrier" signifies culturally pos. individual without history of diarrheal disease within 3 mo. preceding date of 1st pos. test or if, when an attack had occurred, illness proved other than *Shigella* infection. "Chronic carrier," as in typhoid, applies to any carrier state known to have continued more than 1 yr. Convalescent and passive carriers of *Shigella dysenteriae* occur commonly. Individuals recovered from diarrheal disease may disseminate infection for days, wk. or mo. Large proportion may be identified with relative ease if cases of diarrheal disease and contacts promptly studied with new highly selective culture media. *VIII. Sulfaguanidine in the Control of Shigella Dysenteriae Infections.* A. V. HARDY, JAMES WATT AND JEROME PETERSON. *Ibid.* **57:** 529. Use of chemotherapy in control of *Shigella dysenteriae* infections gave promising results and warrants adequate trial.—*Ralph E. Noble.*

Gastro-Enteritis and Public Water Supplies. CHARLES R. COX. Univ. Wis. Symposium Hydrobiol. ('41) p. 260. Water-borne gastro-enteritis probably of bacterial origin. Present water treatment processes adequate if properly applied and controlled. Reported failure of chlorination to destroy intestinal pathogens may be due to survival of resistant strains, but more probably due to temporary ineffective treatment or to lower germicidal effect of chlorine under special conditions. Chlorine residuals should be detd. by both ortho-tolidine and flavone tests, lower value being taken. Control of stream poln. and sewage chlorination also factors in control of water-borne diarrheal disease. More extensive sampling of public water supplies needed as basis of control of qual. of water actually delivered.—*C.A.*

Sulfaguanidine Noneffective in the Treatment of Typhoid Fever and Typhoid Carriers. JAMES WATT AND JEROME S. PETERSON. U.S. Pub. Health Rpts. **57:** 872 (June 5, '42). Sulfaguanidine widely used in treatment of bacillary dysentery with considerable success. Use suggested for *S. typhi* infections. 6 hospitalized, moderately ill patients with proven typhoid fever placed on sulfaguanidine therapy. In addn., cultures made from 3 known chronic typhoid carriers daily, 6 days, then carriers placed on sulfaguanidine. Evident from results that with doses used, latter not effective in treatment of *S. typhi* cases or carriers. —*Ralph E. Noble.*

Single Dose Immunization Against Typhoid and Paratyphoid A and B With Alum-Precipitated T.A.B. Vaccine. ALBERTO P. LEON, FERNANDO ESCARZA AND EMILIO RABASA. Rev. Inst. Salub. y Enferm. Tropicales (Mex.) **2:** 161 (Sept. '41). Prepn. technic of alum-pptd. anti-typhoid and anti-typhoid-paratyphoid vaccines described. Expts. have shown that single dose of alum-pptd. vaccines gives as high or higher immunity as three doses of std. vaccines. Local and general reactions caused by alum-pptd. vaccine about same as those caused by one of std. vaccine doses. Use of alum-pptd. vaccines recommended for individual and mass immunization.—*J. M. Sanchis.*

An Outbreak of Paratyphoid Fever in the City of North Battleford, Saskatchewan. R. O. DAVISON. Can. Pub. Health J. **33:** 205 (May '42). During July–Sept. '41, 65 cases of typhoid and paratyphoid, with 3 deaths, occurred in North Battleford, city of 5,500 pop. Water supply, derived from wells and treated intermittently with hypochlorite, showed no evidence of contamn., nor did milk supply, which is pasteurized. Sewage treatment plant of activated sludge type, effluent being discharged through open ditch 1 mi. long into Saskatchewan R. Source of infection believed to have been vegetables grown on truck farm operated by Chinese adjacent to sewage plant. Operators of farm had made practice of diverting sewage effluent from ditch for irrigation purposes and suspected that this water used also for washing vegetables as no other source of supply found on farm.—*R. E. Thompson.*

Domestic Water and Dental Caries. H. T. DEAN, P. JAY, F. A. ARNOLD JR. AND E. ELVOVE. *I. A Dental Caries Study Including L. acidophilus Estimation of a Population Severely Affected by by Mottled Enamel and Which for the Past 12 Years Has Used Fluoride-Free Water.* U.S. Pub. Health Rpts. **56:** 365 (Feb. 28, '41); *II. A Study of 2,832 White Children, Aged 12–14 Years, of 8 Suburban Chicago Communities, Including L. acidophilus Studies of 1,761 Children. Ibid.* **56:** 761 (Apr. 11, '41). (*Both abstracted,* Jour. A.W.W.A. **33:** 1298 (July '41).) *III. Fluorine in Human Saliva.* F. J. MCCLURE. Am. J. Dis. Children **62:** 512 (Sept. '41). Data from pooled specimens of saliva collected in various cities, where fluorine (F) content of drinking water ranged from 0.0 to 1.8 ppm., do not show consistent relationship between F level in drinking water and F content of saliva. Concn. in latter about 0.10 ppm. Function of normal or greater F content in saliva as partial preventive of dental caries, remains to be demonstrated. *IV. Effect of Increasing Fluoride Content of a Common Water Supply on the Lactobacillus acidophilus Counts of the Saliva.* F. A. ARNOLD JR., H. T. DEAN AND E. ELVOVE. U.S. Pub. Health Rpts. **57:** 773 (May 22, '42). Epidemiological studies pointed to inverse correlation between amt. of dental caries fluoride (F) presence in domestic water supplies. Recent evidence indicated teeth calcified on high F water seemingly retained increased resistance to dental caries even though they had been under influence of F-free water 12 yr. immediately preceding examn. Garrettsville, Ohio, recently changed pub. water supply with 0.1 ppm. F to one of 0.7 ppm. Opportunity thus presented to study children in relation to change. Authors present prelim. results from study of 109 pub. school children exposed about 2 yr. to domestic water of increased F content mentioned. Single clinical examn. indicated dental caries experience rate of these children similar

to rates reported in previous studies on children born and reared in communities where domestic water practically F-free. According to percentage distr. no indication that increased F content has yet influenced *L. acidophilus* counts. This might indicate that first 2 yr. of increased F content would result in little, if any, decreased caries activity of children's teeth calcified and exposed no. of yr. to water practically F-free. Relatively unchanged *L. acidophilus* counts in this group, however, may result from dental caries activity in lesions started prior to water change and still active. Subsequent clinical examns. may show fewer new carious lesions developed since introducing new water supply.—*Ralph E. Noble.*

Human Dental Caries and Topically Applied Fluorine: A Preliminary Report. VIRGIL D. CHEYNE. J. Am. Dental Assn. **29:** 804 (May '42). Drinking water contg. fluorides causes mottled enamel, but, in small amts., prevents tooth decay. Previously believed mottled enamel effect depended on fluorides entering teeth *via* drinking water at early age, during teeth formation. Recent expts. by others suggested entry after teeth eruption. Author swabbed potassium fluoride soln. approx. every 3 mo. on "baby" teeth of 27 four- to six-yr. olds. At beginning, all children had decayed teeth. Yr. later, these children and 19 others with same economic and dental status examd. Latter, untreated group, developed almost twice incidence of new tooth decay as exptl. group. Further tests on more children over longer period needed for final evaluation but present results point to new attack on wide-spread tooth decay problem.—*Ralph E. Noble.*

Association of Dental Caries in School Children With Hardness of Communal Water Supplies. BION R. EAST. J. Dental Res. **20:** 323 ('41). Data from 109 cities of U.S. as to (1) hardness as calcium carbonate of common water supply; and (2) incidence of carious permanent teeth of children showed negative relationship between high hardness and high caries in every case. No signif. relationship found between mean annual hours of sunshine, latitude and hardness of water. Hence hardness-caries relationship factor worthy of consideration in its own right.—*C.A.*

Induced Dental Caries in Rats. *Effect of Subcutaneous Injection of Fluoride.* FRANCIS A. ARNOLD JR. AND FRANK J. MCCLURE. J. Dental Res. **20:** 457 ('41). Subcutaneous injection of 0.5 mg. fluorine as sodium fluoride every second day for 24 days and daily thereafter for 72 days during post-eruptive tooth period produced no signif. reduction in induced dental caries. This subcutaneous injection of sodium fluoride or use of drinking water contg. 10 ppm. fluoride increased fluorine content of enamel and dentin of incisor and erupted molar teeth.—*C.A.*

Condition Suggestive of Threshold Dental Fluorosis Observed in Tristan da Cunha. J. Dental Res. **20:** 303, 315 ('41). *I. Clinical Condition of the Teeth.* REIDAR F. SOGNNAES. Dental fluorosis (mottled enamel) occurred in 15.8% of 3,907 permanent teeth and in 10% of 765 deciduous teeth in inhabitants of island of Tristan da Cunha. Drinking water contains 0.2 ppm. fluorine; but fish, one of richest sources of fluorine among natural foods, in their diet may explain occurrence of lesions and high fluorine content of their teeth. *II. Fluorine Content of the Teeth.* REIDAR F. SOGNNAES AND WALLACE D. ARMSTRONG. In human teeth from Tristan da Cunha, avg. fluorine content of enamel was 0.014% in both dentitions; of dentin 0.027% in permanent teeth and 0.0196% in deciduous teeth. These values 27–60% higher than those in non-fluorosed sound human teeth from Minnesota.—*C.A.*

Factors in the Etiology of Mottled Enamel. FLOYD DEEDS. J. Am. Dental Assn. **28:** 1804 ('41). In production of defective enamel in rats, toxic action of fluorine may be associated with its inhibitory action on phosphatase. Susceptibility to fluorine poisoning increased greatly by admin. of either thyroid or thyrotrophic hormone of anterior pituitary. Ingestion of cadmium may produce

enamel dystrophy same as, or similar to, that due to fluorine; thus, addn. of 0.0016% cadmium as cadmium chloride to ration exerted this chronic effect on incisor teeth of albino rats. Cadmium potent inhibitor of bone phosphatase.—*C.A.*

Toxic Contaminants of Drinking Water. L. T. FAIRHALL. Civ. Eng. (Br.) **37:** 84 (Apr. '42). Contamn. from arsenic, selenium or fluorine occasionally matter of concern and may arise from water in contact with heavily mineralized formations. Until sealing of abandoned mines enforced, 2.7 million tons sulfuric acid annually poured into rivers and streams east of Miss. R. Prior to introduction of recovery processes, phenol wastes to extent of 8,000 to 10,000 tons annually entered Emscher R. in Germany. Of substances that have at times been reported as contaminants of drinking water, following are prominent: acids, arsenic, boron, chlorides, chromates, disinfectants, copper, fluorides, saline wastes, iron, lead, manganese, selenium, sodium hexametaphosphate and zinc. Serious contamn. of water supply derived from watershed on which extensive use of lead arsenate spray material in orchards not shown. Individual instances of contamn. of drinking water with arsenic occur occasionally. Mackenzie cites case of water collected from roofs painted with "pyrites," which contained $\frac{1}{8}$% gpg. arsenic. Contamn. of well water on farm cited by Wyllie as cause of illness and one fatality. Well water found to contain 0.4 to 10 ppm. arsenic as As_2O_3. Boron reported in water in Calif. and Italy. Goudey found boron content of Los Angeles supply varied from 0.5 to 1.5 ppm. Calcium a dietary necessity. Objection to large amts. of calcium salts largely economic problem. While salts of trivalent chromium have been shown to be harmless those of hexavalent chromium have long been known as irritants. Physiological effect of copper controversial subject for years. In long run, copper causes gastro-intestinal catarrh. On the other hand, milk anemia not produced in animals receiving supplementary ration of both iron and copper. Except in cases of overdosage of water with copper sulfate, or where very acid water conveyed in copper pipe, copper content of water runs low. Traces of fluorides found in many drinking waters. Acute toxic effect of sodium fluoride in drinking water occurs at about 180 ppm. fluorine. Retention probably occurs in human when fluorine present to extent of 2 to 3 ppm. Presence of lead in drinking water, except in traces, unusual. Most contamn. probably due to improper use of lead piping. In Leipzig, samples of water taken in early morning, where water had laid in pipes, contained 5.3 ppm. Pb, and danger limit shown to be 2 ppm. Manganese salts produce no noticeable effect except when administered in large amts., or when in form of manganates or permanganates. Avg. daily intake in man about 10 mg. Little known concerning physiological action of sodium hexametaphosphate. If broken down in stomach to sodium phosphate, little need for agitation over problem. Little known of selenium poisoning in man. Most knowledge of selenium poisoning relates to livestock through eating seleniferous grain. Amts. of selenium occurring naturally in water appear to be quite low. Content from Colorado R. basin ranges from 0 to 400 parts per billion (Br.). Zinc compds. and certain industrial wastes indicated in drinking water by objectionable taste before becoming of hygienic importance.—*H. E. Babbitt.*

Metallic Contamination of Hot Water From Cylinders of Bare and Tinned Copper. L. WILKINSON AND S. H. WILSON. Analyst (Br.) **66:** 322 ('41). British Std. Specification No. 39 requires domestic hot-water cylinders to be tinned. Doubt as to desirability of tinning felt by Elec. Eng. Divisional Com. of N.Z. Stds. Inst. because tinning, unless well done, accelerated corrosion. Only health danger to be considered was presence of copper in heated water. Amt. of copper previously found not sufficient to be harmful, although there might be danger from this metal through its catalytic destruction of Vitamin C. Expts. accordingly conducted on effect of several soft waters on no. of tinned and untinned cylinders. Chem. and spectro-

graphic anals. made of hot waters from cylinders installed for periods ranging from 1 day to 7 yr. Copper content tended to lessen with age of cylinder. With neither tinned nor untinned cylinders did copper content reach to the level of 1.0 mg./l. Considered by Copper Development Assn. that 1.4 mg./l. copper cannot be considered dangerous to health. Undesirable amts. of lead found in water from recently installed tinned cylinders, but after year's service, amt. diminished to safe limit. Recommended that hot water for culinary purposes not be used from cylinders for some months after installation. Addnl. cost of tinned cylinders only justified where water known to be aggressive. Tinning required for non-pressure "spill-over" class of cylinders, and for copper reservoirs. Wherever tinning necessary, should be done with very great care and precision and tin should comply with B.S.S. 843—1939 (lead under 0.25%). Further investigation into question of whether small amts. of copper in water would cause serious loss of Vitamin C from vegetables during cooking needed.—*B.H.*

Relation of Copper and Brass Pipe to Health. FRANK E. HALE. W.W. Eng. **95:** 84, 139, 187, 240 (Jan. 28, Feb. 11, 25, Mar. 11, '42). Author presents results of thorough and exhaustive survey of effect of Cu and Cu salts (and Zn) on human beings. [Bibliography of over 150 titles suggests extent of survey.] Discussion gives in considerable detail reasons for author's general agreement with a N.E.W.W.A. Com. report on Cu: (1) Cu content of domestic drinking water after passing through Cu or brass pipe, or tubing, even if slight amt. of Cu taken in soln., not harmful to health and may indeed be beneficial. (2) Water passing through proper installation of Cu or brass pipe will contain but small percentage of permissible Cu content, if any at all. (3) Permissible Cu content of domestic water (1 gpd. consumption) should apparently be $\geq$ 20 ppm. (4) Unlikely that health will be injured by Cu, because water with $\geq$ about 5 ppm. Cu will generally have taste so disagreeable as to be virtually impossible to drink—with pH of 6.5, Cu content, even after standing for appreciable period in pipe, will be only about 0.50 ppm. (5) $CuSO_4$ treatment of reservoirs has no injurious effect on health. Chronic Cu poisoning has never been proved; tests on various animals have shown no harmful effect with following doses: (1) dogs—½ g. CuAc per day for 24 days, one dog, 5 g. per day; (2) sheep—2 g. per day (1 sheep lived 53 days, another, 128). Food cooked and cooled in Cu vessels shown by expts. to be harmless; some individuals can take Cu even to amt. of 400 to 500 mg. daily for weeks without detriment to health; one authority reports 0.05 to 0.2 g. Cu caused only vomiting and diarrhea. Cu found in various foods, in certain kinds of cheese, chocolate, *caffe bourbon*, beef and bread. $CuSO_4$ a sterilizing agent. Epidemic of water-borne typhoid fever should, in general, be controlled and quickly eradicated with soln. of $CuSO_4$ in concn. weaker than 1 to 100,000; 1 to 2,000,000 concn. sufficient in most cases, even less in certain kinds of water. Cu and N coins smeared with cultures of pathogenic bacteria, completely sterile in few hours. Intestinal bacteria, like colon and typhoid, completely destroyed by placing clean Cu foil in water contg. them. Pages 49–54 [of original report] with opinions of eminent doctors, contains summary: "There is no authentic record of fatal Cu poisoning, and many of the best authorities do not consider Cu a true poison; they hold that it is a natural constituent of the body, and in minute quantities has no effect on man." Kellerman & Beckwith in '06 reported complete removal of *Eberthella typhosum* in 10 hr. by 1:2,000,000 diln. and of *Shigella dysenteriae* in 24 hr. by 1:1,500-000 diln. of $CuSO_4$. With fresh, virulent typhoid bacteria isolated directly from patients, Dr. D. D. Jackson found diln. of 1:50,000 effective with practically complete killing with 1:100,000 ($CuSO_4$). Dr. Herbert E. Smith, Yale Med. School, states that one must distinguish sharply between irritant action which Cu salts produce on mucous membranes of stomach and intestines when swallowed, and on effect they produce upon cells of interior organs after absorbed into blood. First effect would be produced by inges-

tion of large dose, i.e., several grams $CuSO_4$, and would be manifested by nausea, vomiting, colic, diarrhea, and other symptoms of gastro-enteritis. Several authorities cited to show that small amts. Cu beneficial. Iowa Agric. Expt. Sta. issued report stating that Cu fed in form of $CuSO_4$ of significance in animal nutrition, particularly from standpoint of making it possible for Fe to be assimilated properly. Other tests with $CuCO_3$ regularly included in feed resulted in healthier animals and better yields. McHargue (Ky. Expt. Sta.) states Cu normal constituent of egg yolk, germs of seeds, livers of animals and of Ky. blue grass. In '28, group of Wis. chemists announced Cu essential factor in diet to keep blood red and body vigorous. Fe of no value in body unaccompanied by Cu, daily Cu requirement probably about 2 mg. per day, and practically all forms of Cu show equal availability (Elvehjem). Negus, in summary, states, among other things, with regard to Cu: "time may come when it will be considered by public health officials to be advantageous biochemically to have traces of Cu in public water supplies." Zn discussed in report because this metal the other main constituent of brass pipe. Early references in literature to Zn poisoning probably not due to Zn but to impurities such as Pb or As. Extended use of galvanized pipe without any apparent effect on health strong proof Zn not harmful. Mason reported (in '00) that avg. of 18.46 ppm. Zn in one supply and 8.65 ppm. in another had no effect on consumers. In Brisbane, water in common use contained 14.3 ppm. Zn, yet no harmful effects observed. Bartow and Weigle (in '32) reported waters contg. as high as 50 ppm. Zn found; this water used by cattle with no apparent harm; carp and catfish found in it and frogs and turtles seen. Cattle and men drank water with content of 39 ppm. Zn, and many waters found in common use contg. 10 to 12 ppm. Zn. Several authors believe present U.S.P.H.S. stds. limit of 5 ppm. Zn unnecessarily low. Question arises how much of these elements may be commonly expected to appear in water passing through Cu or brass pipe of various compn. Pipes in use are: Cu, brass or Cu to Zn ratio of 60:40 (so-called Muntz metal), 67:33 (yellow brass) and 85:15 (red brass). When new all these may show initial action, this usually decreases due to character of film formed on pipe surface. Author gives several generalized statements: (1) Soft waters with low CO_2 will show little corrosion of Cu and brass pipe. Blue stains of Cu produced by few tenths of 1 ppm. of no san. signif. Slight dezincification with such waters decreases within few weeks. (2) Soft waters with considerable CO_2 (10 ppm. and up) may corrode Cu and dezincify yellow brass pipe. With Cu pipe as much as 5 ppm. Cu may be produced and several parts appear for long periods. These waters will dezincify ordinary brass pipe so that hot water pipes may leak within 3 yr., particularly at threads. Red brass pipe, however, reported to be generally satisfactory. (3) Hard waters may dezincify brass by dezincification, especially in hot services, due to CO_2 set free from alky. (4) Softened waters, especially zeolite treated, corrode hot brass pipe, red brass stands up better. (5) Waters that have passed through bone char will contain phosphate and corrode brass in hot water pipes, as will well waters contg. high NO_3 and Cl. (6) Highly alk. waters with high pH may dezincify brass pipe, either uniformly or in form of pits. Grounding elec. currents to brass pipe may cause pitting. Pipe material should be chosen to fit water supply; even then temporary trouble may be experienced and measures may be needed to prevent extended trouble. After making extensive corrosion expts. with Ottawa (Can.) water, Stockwell ('41) states: "Based on figures obtained, very conservative estimate of comparative life of Cu pipe exposed to Ottawa water would be more than 300 times that of pipe made from any type of unprotected iron and more than 30 times that of galvanized iron. . . ." Raising pH reduces corrosion of Cu, values of 7.8 or higher usually sufficient to reduce the action on Cu to min. CO_2, rather than O, seems to be controlling factor. Overtreatment and too high pH values to be

avoided since alk. waters may be as aggressive as acid ones toward certain metals, particularly Zn. At Albany, N.Y., pH of 9.6 reduced to 9.0 because of trouble with galvanized hot water boilers. "As a general summary, it may be expected that Cu and brass pipes will serve a water clear and palatable with most supplies, that the pipes will give long service, that clogging of the pipes will not generally be experienced (except for heating coils with high alkalinity water), that corrosion due to high free CO_2 may be prevented easily, that Cu and Zn are not cumulative poisons, in fact, small amounts appear to be necessary not only for plants but for health of human beings, that the taste of water is an ample safeguard since far larger quantities of either Cu or Zn would be necessary to injure health than to produce disagreeable taste." Pipes should be flushed clear of deposits especially when new, and in early mornings after water has had chance to stand in contact with pipe all night. Radios should not be grounded on water pipe because of possibility of corrosion or taste production.—*Martin E. Flentje.*

Intoxication by Manganese in Well Water. R. KAWAMURA, H. IKUTA, S. HUKUZUMI, R. YAMADA, S. TUBAKI, T. KODAMA AND S. KURATA. Kitasato Arch. Exptl. Med. (Jap.) **18:** 145 ('41). 16 persons, 3 of whom died (1 by suicide), poisoned by drinking well water. Symptoms corresponded to disturbance of extrapyramidal motor tract. One autopsy revealed atrophy and disappearance of nerve cells of globus pallidus. Changes resembled those of Mn poisoning. Animal tests and histol. examns. excluded encephalitis. Early symptoms of poisoning were lethargy and edema. Poisoning more severe in older persons. No sex difference. Considerable Mn and Zn found in this water, in viscera of autopsy case and in blood and urine of poisoned individuals. Zn appeared to bear no relation to symptoms or pathol. changes found in tissues. Poisoning caused by Mn dissolved in well water from old dry cells buried around well. Work on Mn poisoning reviewed.—*C.A.*

The Mosquito-Breeding Possibilities of Static Water Supplies. ANON. Wtr. & Wtr. Eng. (Br.) **44:** 75 (Apr. '42). Article concerned with static water tanks, etc., having bituminous linings, of special interest and importance to fire fighting, public health and other authorities. Mosquitoes can be prevented from breeding by: (1) draining away, (2) putting oil upon, or (3) mixing chems. with water. In Great Britain, 30 distinct species of mosquitoes. Their destruction often necessitates eng. operations of complex and extensive nature. Selection of larvicidal substances for tank-breeding mosquitoes requires care since they have to be non-injurious to receptacles concerned. Oiling water must on no account be resorted to where asphalt and bituminous linings employed. Larvicides based on coal-tar derivatives both economical and effective. Static water supplies or open-air tanks need never be changed during Oct. to Mar. and rarely, if ever, during other months unless to allay public apprehension. Static water stored in covered tanks may provide breeding facilities. Disinfectant solns. based on coal-tar derivatives added to infested water in proportions varying from 1 part in 28,000 to 1 in 50,000. Breeding may be prevented by covering tanks with fine mesh netting.—*H. E. Babbitt.*

Studies on Dry Sterilization. K. B. RIDDLE AND P. S. PRICKETT. (*Published in abstract only.*) J. Bact. **43:** 117 (Jan. '42). Point out necessity for dry sterilization in certain commercial applications where heat cannot be used. Comparisons of results obtained by various methods of dry sterilization show most satisfactory one to be based on insecticidal method using ethylene oxide. By adapting this method, shown that either pure ethylene oxide or mixt. of same with carbon dioxide can be used to effect dry sterilization of micro-organisms. With this adaptation, both food and non-food products shown to be successfully sterilized. Soil samples of high counts, among non-food products, sterilized when treated by this method, using pure ethyl-

ene oxide, in detg. germicidal effects under severe conditions. [How about application to dry glassware when dry heat or steam unavailable, as in the field or under war conditions?]—*Ralph E. Noble.*

Drinking Water—Making It Available on the Job. ANON. Natl. Safety News **45:** 3: 162 (Mar. '42). Satisfactory water cooling system involves: (1) Sufficient capac. for no. of persons to be served, with due consideration for type of work performed, temp. of workroom, etc.; (2) purity of water; (3) cleanliness and appearance of dispensing equip.; (4) convenient location of outlets; and (5) proper water temp. Portable drinking fountains now commercially available. One model uses pump like bicycle pump to maint. pressure. Slight pressure on valve releases jet at angle. Guard prevents workers' lips from contacting nozzle. Insulated sides and bottom keep water cool several hr.—*Ralph E. Noble.*

Water Pail and Dipper Outmoded; Sanitary Drinking Cups Used Here. ANON. Badger Ordnance News. **1:** 6: 1 (May 8, '42). Every worker in Badger Ordnance Works drinks tested water, from clean containers, in paper cups used only once. Some water hauled to plant site from regulated source in 960-gal. trucks. All water tested frequently by state and complete records maintd. At plant, water put in 20 100-gal. tanks distributed about site. Water boys carry around insulated and iced 50-lb. containers, refilled from tanks. Containers provided with paper cups and bracket for salt used in summer mo. by every worker to off-set heat effects. Big tank equip. disinfected and 50-lb. dispensers cleaned weekly, hoses semi-weekly. Each field tank kept cool by insulation with 20 bu. of saw-dust. Est. 10 cups of water per capita used during warm summer days. 30 water coolers in offices iced and filled daily.—*Ralph E. Noble.*

Changes in Selective Service Policies Re: Dependency and Nature of Occupation

Release of July 14, 1942

[To permit water works superintendents and managers, and water works board and commission members, to obtain an over-all view of the current plans of the Selective Service System, the entire, extended text of the Selective Service System release of July 14 is given below. After the detailed consideration of men with dependents—which is worthy of careful study—there is given a clarification in general terms of a "necessary man in a critical occupation essential to the war effort or war production." The specific references to health and water supply in this release, as well as Bulletin No. 10, given on page 41 of the A.W.W.A. mailing to all members under date of July 15, should be helpful to all concerned in presenting the proper picture to local draft boards.—HARRY E. JORDAN, *Secretary, A.W.W.A.*]

EMPHASIZING that the fundamental purposes of the Selective Training and Service Act of 1940, as amended, are procurement of sufficient men for the armed forces and maintenance of production essential to win the war, Maj. Gen. Lewis B. Hershey, Director of Selective Service, declared on July 14 that, insofar as is practical in carrying out these requirements, the *bona fide* family relationship of registrants would be protected as long as possible.

At the same time, National Selective Service Headquarters announced distribution to its agencies of a list of 34 broad essential activities compiled by the War Manpower Commission. The list, which includes under broad activity classifications "the products, facilities, and services considered necessary to war production and essential to the support of the war effort," was prepared to guide local boards when considering individual registrants for occupational classifications but in no way alters the statutory ban on group deferments.

With regard to protection of family relationships and dependents, National Headquarters issued amendments to its Regulations and a memorandum supplementing recently outlined broad policies for induction of

single men with dependents and married men who maintain *bona fide* family relationships in their homes with wives, children, or both.

Broadly, the amendments and memorandum break down Class III-A and Class III-B (the first for the registrant with dependents who does not contribute to the war effort, and the second for the registrant with dependents who does contribute to the war effort) so that when selecting men for induction the local boards may give consideration to both their dependency status and activity in war work.

This breakdown authorizes local boards to consider for selection registrants as follows: (1) Single men with no dependents; (2) single men who do not contribute to the war effort but who have dependents; (3) single men with dependents and who contribute to the war effort; (4) married men who are not engaged in the war effort but who maintain a *bona fide* family relationship with a wife only; (5) married men who are engaged in the war effort and who maintain a *bona fide* family relationship with a wife only; (6) married men who are not engaged in the war effort and who maintain a *bona fide* family relationship with wife and children or children only, and (7) married men who are engaged in the war effort and who maintain a *bona fide* family relationship with wife and children or children only.

In all cases the dependency status must have been acquired prior to December 8, 1941, and at a time when induction was not imminent.

While outlining a broad policy for the induction of men with dependents, the amendments stress that the major requirement of the local board is to meet the manpower needs of the armed forces and to insure an adequate supply of manpower for production of materials of war.

Preparing to carry out its stated policy with regard to induction of men, National Headquarters said that all local boards will make every possible effort to insure that the calls made upon them are met on schedule during the period in which the amended dependency policy is being placed in effect. Local boards, therefore, are authorized to vary from the general order of selection of registrants with dependents when it is necessary to fill a call, provided the registrants who are selected were classified as available for military service under former regulations.

Former regulations provided that for a registrant to be considered as having dependents, one or more persons must be dependent upon his earned income for support in a reasonable manner. Present regulations permit a local board to consider the wife or child of a registrant as dependent if he maintains *bona fide* family relationship with them in his home, and if the marriage took place prior to December 8, 1941, and at a time when induction was not imminent even though the registrant's earned income is not required for the financial support of the dependents.

Furthermore, to carry out its present policy, National Headquarters said that all registrants without dependents of any kind under the law and regulations shall be selected for induction as rapidly as they can be made available.

When the supply of single men without dependents and who are not "necessary men," in any local board area is exhausted and when, in the opinion of the local board it shall become necessary to meet anticipated calls, National Headquarters said the local board may then review in sequence of their order numbers, the classification of all registrants who have been placed in Class III-A by reason of having one or more of the following persons dependent upon them: Wives or children (with whom they do not maintain a *bona fide* family relationship in their homes); parents, brothers, sisters, grandparents, grandchildren, divorced wives, persons under 18 years of age whose support has been assumed in good faith, or persons of any age physically or mentally handicapped whose support has been assumed in good faith. Classification of all such registrants shall be reopened and considered anew, with the local board applying actual support as the sole basis for continued deferment in Class III-A. By this review, it was pointed out, some registrants may be reclassified to Class I-A because of changes in financial status.

When the local board has reopened the classification of substantially all registrants in Class III-A having the types of dependents outlined in the preceding paragraph, and has reclassified them in the manner provided, if it shall appear to the local board that such action is necessary to meet anticipated calls, the local board then may reopen and consider anew the classification of all registrants in Class III-B having the same types of dependents.

When the local boards have reclassified substantially all registrants in Class III-A and Class III-B with these types of dependents, and shall consider it necessary to meet anticipated calls, the local boards are then authorized to review in sequence of their order numbers, the classification of all registrants in Class III-A who have wives (but no children) with whom they maintain a *bona fide* family relationship in their homes. The classification of all such registrants shall be reopened and considered anew, applying actual support as the sole basis for continuing deferment in Class III-A. Following reopening of classifications of substantially all registrants in Class III-A having wives but no children with whom they maintain a *bona fide* family relationship in their homes and reclassification on the basis of actual support, the local board then may reopen and consider anew the classification of all registrants in Class III-B who have wives but no children with whom they maintain a *bona fide* family relationship.

In all instances where it becomes necessary for the local board to reconsider classifications of men with one type of dependents, the local board is directed by National Headquarters to notify the State Director of Selective Service before proceeding to the reclassification of men with another type of dependent. Such notification will keep the State Director constantly informed of the progress of local boards toward reclassification of all groups so that he may adjust his calls for men to prevent one local board from calling registrants from one group substantially in advance of the time when other local boards are calling them from that same group.

When it becomes necessary to reclassify registrants who have wives and children, or who have children only, with whom they maintain a *bona fide* family relationship in their homes, the classification of those in Class III-A will first be reopened, followed by those in Class III-B.

Description of a "Necessary Man"

In all cases of reclassification, National Headquarters emphasized that consideration shall be given to deferment in Class II-A or Class II-B of the registrant who is not continued in Class III-A or Class III-B but who may be a "necessary man" in a critical occupation essential to the war effort or war production as defined by Selective Service Regulations.

The list of civilian activities necessary to war production and essential to the war effort, which may be used to guide local boards in considering occupational classification of registrants, specifies that such activities must meet one or more of the following tests:

(a) that the business is fulfilling a contract of the Army, Navy, Maritime Commission, or other Governmental agencies engaged directly in war production;

(b) that the business is performing a Governmental service directly concerned with promoting or facilitating war production;

(c) that the business is performing a service, Governmental or private, directly concerned with providing food, clothing, shelter, health, safety, or other requisites of the civilian daily life in support of the war effort;

(d) that the business is supplying material under subcontracts for contracts included in (a), (b), or (c), above; or,

(e) that the business is producing raw materials, manufacturing materials, supplies, or equipment, or performing services necessary for the fulfillment of contracts included in (a), (b), (c), or (d) above.

Having found that the business in which a registrant is engaged comes under some group in the list of 34 classifications, and having applied the tests and made the determination that it is an essential activity, consideration will be given to the occupation of the registrant, within that activity,

and if he is found to be a "necessary man" as defined by Selective Service Regulations, occupational classification may be made by the local board.

Of the 34 broad essential activity classifications, the three following are of particular interest in the water works field:

Health and Welfare Services, Facilities and Equipment: Water supply and sewerage systems; irrigation systems; dental and medical laboratories; hospitals; nursing services; fire and police protection; public health services; weather services; coast and geodetic services; engineering and other testing laboratories; offices of dentists, physicians, surgeons, osteopaths, chiropodists and veterinarians; professional engineering services. Includes also the manufacture of x-ray and therapeutic apparatus, and of surgical, medical and dental instruments, equipment and supplies.

Governmental Services: Including services necessary for the maintenance of health, safety, and morale, and the prosecution of the war.

Heating, Power and Illuminating Services: Electric light and power and gas utilities; steam-heating companies.

EDITOR'S NOTE: *Other pertinent information on the relation of the Selective Service System to water works men will be found in the following:*

Selective Service Memorandum (I–405) Re: Occupational Classification. Jour. A.W.W.A., **34:** 970 (1942).

Selective Service Occupational Bulletin No. 10 Re: Scientific and Specialized Personnel and Text of DSS Form 42A. A.W.W.A. Information on Wartime Water Works Practice, Special Mailing of July 15, 1942, p. 41.

In addition to the above release of July 14, there was a release (PM–3736) on July 6 by the War Manpower Commission, listing 138 occupations which are essential to war production and in which there is a national shortage of labor. The 138 occupations are chiefly machine, tool, aircraft and shipbuilding categories. It is currrently understood that the list issued on July 6 will be soon amended to include water works occupations.

Amendment to Preference Rating Order P-46

PREFERENCE Rating Order P-46, as amended, was further amended July 23, in Supplementary Preference Rating Order P-46-a, to permit utility companies to make extensions to facilities for the Army, Navy or Maritime Commission upon direct order by them.

It was provided, however, that the total length of such gas or water main extension or the electric service line may not exceed 250 ft. and the total cost of material required for the extension may not exceed $1,500 in the case of underground construction or $500 in the case of other jobs.

The purpose of the amendment is to enable the Army, Navy or Maritime Commission to obtain extensions of electric, gas or water service to barracks or other temporary buildings without prior approval of WPB. The order previously required WPB approval of any extension, regardless of the length or the cost of such extension.

EDITORIAL NOTE: Water works operators are cautioned that this order does not authorize extensions except such as may be made "upon direct [*written*] order of the Army, Navy or Maritime Commission" and then only under the limitations noted. Proposed extensions not in accord with or beyond the limit of this order must be applied for by the use of PD1A forms. Extensions to Housing Projects are specifically covered by the terms of the WPB Administrative Letter of June 23, 1942, for which see pp. 30 *et seq.* of "Information on Wartime Water Works Practice," a special mailing to all A.W.W.A. members under date of July 15, 1942.

Rebuilding Damaged Buildings

RECONSTRUCTION of certain types of non-residential buildings damaged or destroyed after July 23 is permitted by Amendment 2 to Conservation Order L-41, provided that immediate restoration is necessary for the prosecution of the war or to protect public health or safety. Under Conservation Order L-41 owners were already permitted to restore damaged residential structures without WPB authorization. Construction authorized under Amendment 2 is defined as all construction other than residential and agricultural, that is, including commercial, industrial, recreational, institutional, highway and utilities. To restore other restricted construction, the builder must seek permission by notifying the WPB by telegraph within five days of damage, setting forth the cause of destruction, function of the structure, estimated cost of repair and reasons why immediate reconstruction is deemed necessary.